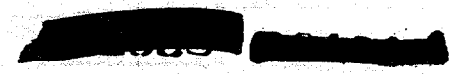


APPENDIX A
DETAILED SPECIFIC USE SITES
FOR
SODIUM AND CALCIUM HYPOCHLORITES



PULP AND PAPER MILL SYSTEMS	AQUATIC NON-FOOD INDUS.
POULTRY DRINKING WATER	INDOOR FOOD
SWIMMING POOL WATER	AQUATIC NON-FOOD RESID.
SPAS AND HOT TUBS-OUTDOOR	AQUATIC NON-FOOD RESID.
ANIMAL/HUMAN DRINKING WATER AND SURFACES	INDOOR FOOD
AIR WASHER WATER	AQUATIC NON-FOOD INDUS.
COOLING TOWER WATER	AQUATIC NON-FOOD INDUS.
EVAPORATIVE CONDENSER WATER	AQUATIC NON-FOOD INDUS.
PONDS-ORNAMENTAL AND FISH	AQUATIC NON-FOOD RESID.
SEWAGE SYSTEMS/WASTE WATER/SEPTIC TANKS	AQUATIC NON-FOOD INDUS.
HEAT EXCHANGER/INDUSTRIAL PROCESSING H2O	AQUATIC NON-FOOD INDUS.
WHIRLPOOL BATH WATER	AQUATIC NON-FOOD RESID.
RESERVOIRS	AQUATIC FOOD CROP
BOATS AND SHIPS	AQUATIC NON-FOOD OUTDOOR
ARTIFICIAL SAND BEACHES	AQUATIC NON-FOOD RES
RECREATIONAL VEHICLES	INDOOR NON-FOOD
FOOD PROCESSING EQUIP.	INDOOR FOOD
FOOD PROCESSING PREMISES	INDOOR NON-FOOD
BAKERY PROCESSING EQUIP.	INDOOR FOOD
BAKERY PROCESSING PREMISES	INDOOR NON-FOOD
BOTTLING PROCESSING EQUIP.	INDOOR FOOD
BOTTLING PREMISES	INDOOR NON-FOOD
BREWERY PROCESSING EQUIP.	INDOOR FOOD
BREWERY PREMISES	INDOOR NON-FOOD
CANNERY PROCESSING EQUIP.	INDOOR FOOD
CANNERY PROCESSING PREMISES	INDOOR NON-FOOD
ICE CREAM PROCESSING EQUIP.	INDOOR FOOD
BUTTER PROCESSING EQUIP.	INDOOR FOOD
MILK PROCESSING EQUIP.	INDOOR FOOD
MILK PROCESSING PREMISES	INDOOR NON-FOOD
CHEESE AGING ROOMS	INDOOR FOOD
CHEESE PROCESSING PREMISES	INDOOR NON-FOOD
MEAT PROCESSING EQUIP.	INDOOR FOOD
MEAT PROCESSING PREMISES	INDOOR NON-FOOD
POULTRY PROCESSING EQUIP.	INDOOR FOOD
POULTRY PROCESSING PREMISES	INDOOR NON-FOOD
WINERY EQUIP.	INDOOR FOOD
WINERY PREMISES	INDOOR NON-FOOD
EGG BREAKING EQUIP.	INDOOR FOOD
BEVERAGE PROCESSING EQUIP.	INDOOR FOOD
BEVERAGE PROCESSING PREMISES	INDOOR NON-FOOD
FISH PROCESSING EQUIP.	INDOOR FOOD
EATING ESTAB./EQUIP./UTENSILS/CONTACT SURF	INDOOR FOOD
EATING ESTAB. NON-FOOD CONTACT SURFACES	INDOOR NON-FOOD
COMMERCIAL/INDUSTRIAL/STORAGE PREMISES	INDOOR NON-FOOD
GROUTS/AWNINGS	RESIDENTIAL OUTDOOR
LAUNDRY-HOUSEHOLD	INDOOR RESIDENTIAL
LAUNDRY-COMMERCIAL	INDOOR NON-FOOD
DOMESTIC DWELLINGS	INDOOR RESIDENTIAL
BATHROOM PREMISES/URINALS/TOILETS	INDOOR RESIDENTIAL
INDUSTRIAL PROCESS PLANT PREMISES	INDOOR NON-FOOD
INSTITUTIONAL PREMISES	INDOOR NON-FOOD

ENVIRONMENTAL INANIMATE HARD SURFACES

"
HEMODIALYSIS MACHINES

HOSPITAL PREMISES

FURNITURE-OUTDOOR

ROOFS

SHOWER CURTAIN SURFACES

TILE-CERAMIC/TILE SURFACES

SURFACES-PAINTED OR UNPAINTED/FINISH WOOD

"

HARD NONPOROUS SURFACE

"

"

ASPHALT ROOFS/ROOFS-WOOD

AUTO TOPS

WALL SURFACES/WALL-BRICK

"

ASBESTOS ROOFS/SHINGLES

INDOOR MEDICAL

INDOOR RESIDENTIAL

INDOOR MEDICAL

INDOOR MEDICAL

RESIDENTIAL OUTDOOR

RESIDENTIAL OUTDOOR

INDOOR NON-FOOD

INDOOR NON-FOOD

INDOOR NON-FOOD

RESIDENTIAL OUTDOOR

INDOOR NON-FOOD

INDOOR MEDICAL

INDOOR FOOD

RESIDENTIAL OUTDOOR

RESIDENTIAL OUTDOOR

INDOOR NON-FOOD

RESIDENTIAL OUTDOOR

RESIDENTIAL OUTDOOR

USE GROUP SUMMARY: TERRESTRIAL FOOD CROP, TERRESTRIAL FEED CROP,
TERRESTRIAL NON-FOOD CROP, AQUATIC FOOD CROP, AQUATIC NON-FOOD
OUTDOOR, AQUATIC NON-FOOD INDUSTRIAL, AQUATIC NON-FOOD RESIDENTIAL,
RESIDENTIAL OUTDOOR, INDOOR FOOD, INDOOR NON-FOOD, INDOOR MEDICAL,
INDOOR RESIDENTIAL.

SODIUM HYPOCHLORITE

(14703)

SITES (APPLICATION TYPES-IF GIVEN)	USE GROUPS
CITRUS-INC. GRAPEFRUIT, ORANGES, LEMONS	TERRESTRIAL FOOD CROP
"	TERRESTRIAL FEED CROP
APPLES	TERRESTRIAL FOOD CROP
"	TERRESTRIAL FEED CROP
PEARS	TERRESTRIAL FOOD CROP
QUINCES	TERRESTRIAL FOOD CROP
STONE FRUITS	TERRESTRIAL FOOD CROP
CHERRIES	TERRESTRIAL FOOD CROP
NECTARINES	TERRESTRIAL FOOD CROP
PEACHES	TERRESTRIAL FOOD CROP
PLUMS/PRUNES	TERRESTRIAL FOOD CROP
MELONS	TERRESTRIAL FOOD CROP
CUCUMBERS	TERRESTRIAL FOOD CROP
PEPPERS	TERRESTRIAL FOOD CROP
PIMENTOS	TERRESTRIAL FOOD CROP
PECANS (POSTHARVEST APP TO NON-STRD COMM)	TERRESTRIAL FOOD
TOMATOES (POSTHARVEST APP./SEED TRT)	TERRESTRIAL FOOD CROP
CROP	TERRESTRIAL FEED CROP
"	TERRESTRIAL FEED CROP
BRUSSEL SPROUTS	TERRESTRIAL FOOD CROP
CABBAGE	TERRESTRIAL FOOD CROP
CAULIFLOWER	TERRESTRIAL FOOD CROP
ARTICHOKES	TERRESTRIAL FOOD CROP
LETTUCE	TERRESTRIAL FOOD CROP
CARROTS	TERRESTRIAL FOOD CROP
POTATOES	TERRESTRIAL FOOD CROP
RADISHES	TERRESTRIAL FOOD CROP
SWEET POTATOES	TERRESTRIAL FOOD CROP
ASPARAGUS	TERRESTRIAL FOOD CROP
MUSHROOMS	TERRESTRIAL FOOD CROP
MUSHROOMS	GREENHOUSE FOOD CROP
ONIONS	TERRESTRIAL FOOD CROP
CELERY	TERRESTRIAL FOOD CROP
PEPPERS (SEED TRT)	TERRESTRIAL FOOD CROP
ROSES-CUTTINGS	TERRESTRIAL NON-FOOD C.
SUGAR-RAW	INDOOR FOOD
LIVESTOCK PENS/STALLS/FEEDING/WATER EQUIP.	INDOOR FOOD
FISH (MEAT)	INDOOR FOOD
POULTRY PREMISES/FEEDING/WATERING/TRANSPOR.	INDOOR FOOD
POULTRY (ANIMAL TREATMENT)	INDOOR FOOD
ANIMAL TRANSPORTATION VEHICLES/EQUIPMENT	INDOOR FOOD
ANIMAL TRANSPORTATION VEHICLES/EQUIPMENT	INDOOR NON-FOOD
WOOD SIDING (NONSOIL CONTACT NONFUM. TREAT)	OUTDOOR RESIDENTIAL
SUGARCANE JUICE	INDOOR FOOD
BUTTER PROCESSING EQUIPMENT	INDOOR FOOD
SEWAGE EFFLUENT WATER	AQUATIC NONFOOD INDUS

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ANIMAL CAGES/LIVING QTRS/FEEDING/WATERING	INDOOR NON-FOOD
"	INDOOR FOOD
"	INDOOR RESIDENTIAL
PET SLEEPING QUARTERS	INDOOR NON-FOOD
COMMERCIAL EGG TRT	INDOOR FOOD
DAIRY PREMISES/EQUIP./STORAGE/UTENSILS	INDOOR FOOD
FARM/AGRICULTURAL EQUIP./BARN	INDOOR FOOD
BEEKEEPING EQUIP.	INDOOR FOOD
FISH HANDLING EQUIP.	AQUATIC FOOD CROP
FISH POND EQUIP.	AQUATIC FOOD CROP
BATH MATS	INDOOR RESIDENTIAL
HOUSEHOLD CONTENTS/PREMISES	INDOOR RESIDENTIAL
SICKROOM EQUIP./PREMISES/UTENSILS	INDOOR MEDICAL
SIDING/WOOD SIDING	RESIDENTIAL OUTDOOR
FISH HATCHERIES/PONDS	AQUATIC FOOD CROP
MARINE LOBSTER/OYSTER PONDS.	AQUATIC FOOD CROP
BOTTLE WASHER WATER	INDOOR FOOD
BREWERY PASTEURIZER WATER	INDOOR NON-FOOD
EGG/FOOD PROCESSING WATER	INDOOR FOOD
MEAT/POULTRY/FRUIT/VEGETABLE PROCESSING H2O	INDOOR FOOD
INDUSTRIAL PULP AND PAPER MILL SYSTEMS	AQUATIC NON-FOOD
SWIMMING POOL WATER	AQUATIC NON-FOOD RES.
HOT TUBS/SPAS/ARTIFICIAL SAND BEACHES	AQUATIC NON-FOOD RES.
DRAINS/DRAIN PIPES	AQUATIC NON-FOOD RES.
HUMAN DRINKING WATER	INDOOR FOOD
ANIMAL DRINKING WATER	INDOOR NON-FOOD
COOLING TOWER/EVAPORATIVE CONDENSER WATER	AQUATIC NON-FOOD INDUS.
IRRIGATION SUPPLY SYSTEMS	AQUATIC FOOD CROP
PONDS-ORNAMENTAL FISH/FOUNTAINS	AQUATIC NON-FOOD RES.
SEWAGE SYSTEMS/WASTE WATER SYSTEMS	AQUATIC NON-FOOD INDUS.
DISHWASHING MACHINE WATER	AQUATIC NON-FOOD RES.
INDUSTRIAL PROCESSING WATER	AQUATIC NON-FOOD INDUS.
IMMERSION ULTRASONIC TANK WATER	AQUATIC NON-FOOD INDUS.
WHIRLPOOL BATH WATER	AQUATIC NON-FOOD RES.
PONDS	AQUATIC NON-FOOD OUTD.
RESERVOIRS	AQUATIC FOOD CROP
BOAT BOTTOMS/SHIP HULLS	AQUATIC NON-FOOD INDUS.
TRUCKS	INDOOR NON-FOOD
FOOD PROCESSING EQUIP.	INDOOR FOOD
FOOD PROCESSING PLANT PREMISES	INDOOR NON-FOOD
BAKERY PROCESSING EQUIP.	INDOOR FOOD
BAKERY PROCESSING PREMISES	INDOOR NON-FOOD
BOTTLES/BOTTLING PLANT SURFACES	INDOOR FOOD
BREWERY PROCESS PLANT EQUIP.	INDOOR FOOD
BREWERY PREMISES	INDOOR NON-FOOD
CANNERY PROCESS PLANT PREMISES/EQUIP.	INDOOR FOOD
MILK TRANSPORT. VEHICLES/PROCESS PLANT/EQUIP.	INDOOR FOOD
CHEESE PROCESSING EQUIP.	INDOOR FOOD
FRUIT PROCESSING EQUIP.	INDOOR FOOD
VEGETABLE PROCESSING PLANTS/EQUIP.	INDOOR FOOD
MEAT PACKING EQUIP./PROCESS PLANT PREMISES	INDOOR FOOD
POULTRY PROCESSING EQUIP./PLANT PREMISES	INDOOR FOOD

WINERY PROCESSING EQUIP./PROCESS PLANT	INDOOR FOOD
EGG PROCESSING PLANT/EQUIPMENT	INDOOR FOOD
BEVERAGE PROCESSING EQUIPMENT/CASES/PLANT	INDOOR FOOD
FISH PROCESSING PLANT PREMISE	INDOOR FOOD
EATING ESTABLISHMENT/UTENSILS/FD-CONTACT S.	INDOOR FOOD
FOOD HANDLING SURFACES/PREMISES/UTEN./EQUIP.	INDOOR FOOD
FOOD MARKETS	INDOOR FOOD
AMBULANCES	INDOOR MEDICAL
HOSPITAL INSTRUMENTS/STAINLESS STEEL INTRUM	INDOOR MEDICAL
HOSPITAL PREMISES/LABORATORIES	INDOOR MEDICAL
VETERINARY HOSPITAL PREMISES/MATERIALS	INDOOR MEDICAL
HEMODIALYSIS MACHINES/HOSPITAL MATERIALS	INDOOR MEDICAL
BEDPANS	INDOOR MEDICAL
FLOOR MATS/FLOORS	INDOOR RESIDENTIAL
INDUSTRIAL PREMISES/EQUIP.	INDOOR NON-FOOD
LOCKER/SHOWER ROOM PREMISES	INDOOR NON-FOOD
STORES	INDOOR FOOD
"	INDOOR NON-FOOD
BEDDING-HUMAN/SHOWER CURTAINS	INDOOR RESIDENTIAL
LAUNDRY/EQUIP.	INDOOR RESIDENTIAL
DIAPERS/DIAPER PAILS	INDOOR RESIDENTIAL
"	INDOOR NON-FOOD
BATHROOM PREMISES/SHOWER STALLS/TOILETS	INDOOR RESIDENTIAL
URINALS	INDOOR RESIDENTIAL
CUSPIDORS	INDOOR MEDICAL
GARBAGE STORAGE PREMISES/CONTAINERS/CANS	INDOOR RESIDENTIAL
ENVIRONMENTAL INANIMATE HARD SURFACES	INDOOR MEDICAL
"	INDOOR RESIDENTIAL
AIR TREATMENT-FOOD PROCESS PLANT	INDOOR FOOD
SURFACES	INDOOR NON-FOOD
"	INDOOR FOOD
"	INDOOR MEDICAL
BATHHOUSE SURFACES/SHOWER SURFACES	INDOOR RESIDENTIAL
HARD NONPOROUS SURFACES/HD POROUS SURFACES	INDOOR NON-FOOD
"	INDOOR FOOD
"	INDOOR MEDICAL
ROOFS (ASPHALT AND WOOD)	RESIDENTIAL OUTDOOR
WOOD SURFACES-SEASONED/UNPAINTED	RESIDENTIAL OUTDOOR
FABRIC SURFACES	INDOOR RESIDENTIAL
HUMAN CLOTHING	INDOOR RESIDENTIAL
LAUNDRY (HOSPITAL)	INDOOR MEDICAL
LAUNDRY (COIN-OPERATED)	INDOOR RESIDENTIAL
LAUNDRY (HOUSEHOLD)	INDOOR RESIDENTIAL
FUNITURE (OUTDOOR)	RESIDENTIAL OUTDOOR
STOVE SURFACES	INDOOR RESIDENTIAL

USE GROUP SUMMARY: TERRESTRIAL FOOD CROP, TERRESTRIAL FEED CROP, TERRESTRIAL NON-FOOD CROP, AQUATIC FOOD CROP, AQUATIC NON-FOOD OUTDOOR, AQUATIC NON-FOOD INDUSTRIAL, AQUATIC NON-FOOD RESIDENTIAL, RESIDENTIAL OUTDOOR, INDOOR FOOD, INDOOR NON-FOOD, INDOOR MEDICAL, INDOOR RESIDENTIAL.

APPENDIX B

**Generic Data Requirements for Reregistration
of Sodium or Calcium Hypochlorite and Data Citations
Supporting Reregistration**

APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF SODIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Product Chemistry</u>			
61-1	Product Identity	ABCDEFGKLMNO	00007588
*61-2a	Begin. Mat. and MFG Process	ABCDEFGKLMNO	00007588, 00007226, 00007269, 00025213
*61-2b	Discussion of Impurities	ABCDEFGKLMNO	00007226, 00007588
62-1	Preliminary Analysis	ABCDEFGKLMNO	00007227, 00007271, 00007588, 05011175
63-2	Color	ABCDEFGKLMNO	00007226
63-3	Physical State	ABCDEFGKLMNO	00007226
63-4	Odor	ABCDEFGKLMNO	00007226
63-7	Density	ABCDEFGKLMNO	00007226
63-12	pH	ABCDEFGKLMNO	00007226
63-13	Stability	ABCDEFGKLMNO	00007226

* These guideline numbers were previously 61-2 and 61-3, respectively.

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APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF SODIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Ecological Effects:</u>			
71-1a	Acute avian oral - Quail	ABCDEFGKLMNO	00007276, 00007403
71-2a	Acute avian dietary - Quail	ABCDEFGKLMNO	00007275, 00007405
71-2b	Acute avian dietary - Duck	ABCDEK	00007278, 00007404
72-1a	Fish tox - Bluegill	ABCDEFK	00008190, 00007401, 40911802
72-1c	Fish tox - Rainbow trout	ABCDEFGKLMNO	00008191, 00007400, 40911802
72-2a	Invertebrate tox	ABCDEFGKLMNO	00007279, 00007402, 000019313, 40911802
72-3a	Estu/Mari Tox Fish	ABCDEFK	40911802
72-3b	Estu/Mari Tox Mollusk	ABCDEFK	40911802
72-3c	Estu/Mari Tox Shrimp	ABCDEFK	40911802
72-4a	Early Life Stage Fish	ABCDEFK	40911802
72-4b	Life Cycle Invertebrate	ABCDEFK	40911802
72-5	Life Cycle Fish	ABCDEFK	40911802
72-7	Field Testing - Aquatic Org	ABCDEFK	40911802

APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF SODIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Toxicology</u>			
81-1	Acute oral tox - rat	ABCDEFGKLMNO	00007540, 00020072, 00007397, 00007285, 00007274, 00007399, 00007374, 00007369
81-2	Acute dermal tox - rabbit	ABCDEFGKLMNO	00007374, 00007369, 00007285, 00007277, 00007398, 00020072, 00007540
81-4	Primary eye irritation - rabbit	ABCDEFGKLMNO	00007374, 00007369, 00007274, 00008204, 00008206, 00007221, 00020072, 00007540
81-5	Primary dermal irritation - rabbit	ABCDEFGKLMNO	00007374, 00007369, 00007274, 00008203, 00008205, 00007221, 00020072, 00007540

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APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF SODIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Environmental Fate:</u>			
161-1	Hydrolysis	ABCDEFGK	40911802
161-2	Photodegradation - water	ABCDEFGK	05011199
162-3	Anaerobic aquatic metab	ABCDEFG	40911802
162-4	Aerobic aquatic metab	DEFG	40911802, 05021388
164-2	Aquatic field dissipation	DEFG	40911802
165-3	Accumulation-irrig crop	DEF	40911802

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APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF CALCIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Product Chemistry</u>			
61-1	Product Identity	ABCDEFGKLMNO	00007498
*61-2a	Begin. Mat. and MFG Process	ABCDEFGKLMNO	00007498, 05014892, 05012141
*61-2b	Discussion of Impurities	ABCDEFGKLMNO	40929401
62-1	Preliminary Analysis	ABCDEFGKLMNO	00007498, 05011175
63-2	Color	ABCDEFGKLMNO	00007498
63-3	Physical State	ABCDEFGKLMNO	00007498, 05009652
63-4	Odor	ABCDEFGKLMNO	00007498
63-7	Density	ABCDEFGKLMNO	40929401
63-12	pH	ABCDEFGKLMNO	40929401

* These guideline numbers were previously 61-2 and 61-3, respectively.

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APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF CALCIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
Ecological Effects:			
71-1a	Acute avian oral - Quail	ABCDEFGKLMNO	00007496, 40230102
71-2a	Acute avian dietary - Quail	ABCDEFGKLMNO	00007275, 00007405, 40230104
71-2b	Acute avian dietary - Duck	ABCDEK	00007278, 00007404, 40230103
72-1a	Fish tox - Bluegill	ABCDEFK	40911811, 40911802
72-1c	Fish tox - Rainbow trout	ABCDEFGKLMNO	00007495, 40911802
72-2a	Invertebrate tox	ABCDEFGKLMNO	00007495, 40911802
72-3a	Estu/Mari Tox Fish	ABCDEFK	40911802
72-3b	Estu/Mari Tox Mollusk	ABCDEFK	40911802
72-3c	Estu/Mari Tox Shrimp	ABCDEFK	40911802
72-4a	Early Life Stage Fish	ABCDEFK	40911802
72-4b	Life Cycle Invertebrate	ABCDEFK	40911802
72-5	Life Cycle Fish	ABCDEFK	40911802
72-7	Field Testing - Aquatic Org	ABCDEFK	40911802

APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF CALCIUM HYPOCHLORITE AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Toxicology</u>			
81-1	Acute oral tox - rat	ABCDEFGKLMNO	00007381, 00007580
81-2	Acute dermal tox - rabbit	ABCDEFGKLMNO	00007381
81-3	Acute Inhalation - rat	ABCDEFGKLMNO	00007560, 00007580
81-4	Primary eye irritation - rabbit	ABCDEFGKLMNO	00007580, 00007381, 00007248, 00007249
81-5	Primary dermal irritation - rabbit	ABCDEFGKLMNO	00007580, 00007381, 00008202, 00007248

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APPENDIX B

GENERIC DATA REQUIREMENTS FOR REREGISTRATION OF CALCIUM HYPOCHLORITE
AND DATA CITATIONS SUPPORTING REREGISTRATION

GUIDELINE CITATION	TITLE OF STUDY	USE PATTERNS	BIBLIOGRAPHIC CITATION
<u>Environmental Fate:</u>			
161-1	Hydrolysis	ABCDEFGK	40911802
161-2	Photodegradation - water	ABCDEFGK	05011199
162-3	Anaerobic aquatic metab	ABCDEFG	40911802
162-4	Aerobic aquatic metab	DEFG	40911802, 05021388
164-2	Aquatic field dissipation	DEFG	40911802
165-3	Accumulation-irrig crop	DEF	40911802

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APPENDIX C

SODIUM AND CALCIUM HYPOCHLORITE BIBLIOGRAPHY

**Citations Considered to be Part of the
Data Base Supporting Reregistration**

As a last resort, the Agency has shown the first submitter as author.

- b. Document date. When the date appears as four digits with no question marks, the Agency took it directly from the document. When a four-digit date is followed by a question mark the bibliographer deduced the date from evidence in the document. When the date appears as (19??), the Agency was unable to determine or estimate the date of the document.
- c. Title. In some cases, it has been necessary for Agency bibliographers to create or enhance a document title. Any such editorial insertions are contained between square brackets.
- d. Trailing parentheses. For studies submitted to the Agency in the past, the trailing parentheses include (in addition to any self-explanatory text) the following elements describing the earliest known submission:
 - (1) Submission date. The date of the earliest known submission appears immediately following the word "received."
 - (2) Administrative number. The next element, immediately following the word "under," is the registration number, experimental use permit number, petition number, or other administrative number associated with the earliest known submission.
 - (3) Submitter. The third element is the submitter, following the phrase "submitted by." When authorship is defaulted to the submitter, this element is omitted.
 - (4) Volume Identification (Accession Numbers). The final element in the trailing parentheses identifies the EPA accession number of the volume in which the original submission of the study appears. The six-digit accession number follows the symbol "CDL," standing for "Company Data Library." This accession number is in turn followed by an alphabetic suffix which shows the relative position of the study within the volume. For example, within accession number 123456, the first study would be 123456-A; the second, 123456-B; the 26th, 123456-Z; and the 27th, 123456-AA.

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REREGISTRATION ELIGIBILITY DOCUMENT
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- 00007226 Wonder Chemical Corporation (1977) Product Chemistry Data. Includes methods dated Jul 1977 entitled: Determination of available chlorine in bleach solutions; method dated Jul 1977 entitled: Determination of excess Sodium hydroxide in bleach solutions. (Unpublished study received Apr 25, 1978 under 193-16; CDL:233827-A)
- 00007227 Schultz, H. (1978) Quality Control Laboratory Report: Report No. 9547-A. (Unpublished study received Apr 25, 1978 under 193-16; prepared in cooperation with Dow Chemical Co., submitted by Wonder Chemical Corp., Fairless Hills, Pa.; CDL:233827-I)
- 00007248 Latven, A.R. (1976) Sentry (65% Available Chlorine): Toxicology Report. (Unpublished study including letter dated May 13, 1976 from A.R. Latven to George R. Dychdala, received May 14, 1976 under 335-188; prepared by Pharmacology Research, Inc., submitted by Pennwalt Chemical Corp., Philadelphia, Pa.; CDL:227449-B)
- 00007249 Latven, A.R. (1976) Sentry (30% Available Chlorine): Toxicology Report. (Unpublished study including letter dated May 13, 1976 from A.R. Latven to George R. Dychdala, received May 14, 1976 under 335-188; prepared by Pharmacology Research, Inc., submitted by Pennwalt Chemical Corp., Philadelphia, Pa.; CDL:227449-C)
- 00007269 Hachik Bleach Company (1977) General Chemistry. Includes two methods dated Jul 1977 entitled: Determination of excess Sodium hydroxid in bleach solutions and Determination of available chlorine in bleach solutions. (Unpublished study received May 15, 1978 under 7254-9; CDL:233981-A)
- 00007271 Schultz, H. (1978) Quality Control Laboratory Report: Report No. 9547-DD. (Unpublished study received May 30, 1978 under 7254-9 prepared by Wonder Chemical Corp., submitted by Hachik Bleach Co., Philadelphia, Pa.; CDL:235144-A)

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APPENDIX D

PR NOTICE 91-2



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 2

PR NOTICE 91-2

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

NOTICE TO MANUFACTURERS, PRODUCERS, FORMULATORS,
AND REGISTRANTS OF PESTICIDES

ATTENTION: Persons Responsible for Federal Registration of
Pesticide Products.

SUBJECT: Accuracy of Stated Percentages for Ingredients
Statement

I. PURPOSE:

The purpose of this notice is to clarify the Office of Pesticide Program's policy with respect to the statement of percentages in a pesticide's label's ingredient statement. Specifically, the amount (percent by weight) of ingredient(s) specified in the ingredient statement on the label must be stated as the nominal concentration of such ingredient(s), as that term is defined in 40 CFR 158.153(i). Accordingly, the Agency has established the nominal concentration as the only acceptable label claim for the amount of active ingredient in the product.

II. BACKGROUND

For some time the Agency has accepted two different methods of identifying on the label what percentage is claimed for the ingredient(s) contained in a pesticide. Some applicants claimed a percentage which represented a level between the upper and the lower certified limits. This was referred to as the nominal concentration. Other applicants claimed the lower limit as the percentage of the ingredient(s) that would be expected to be present in their product at the end of the product's shelf-life. Unfortunately, this led to a great deal of confusion among the regulated industry, the regulators, and the consumers as to exactly how much of a given ingredient was in a given product. The Agency has established the nominal concentration as the only acceptable label claim for the amount of active ingredient in the product.

Current regulations require that the percentage listed in the active ingredient statement be as precise as possible reflecting good manufacturing practices 40 CFR 156.10(g)(5). The certified limits required for each active ingredient are intended to encompass any such "good manufacturing practice" variations 40 CFR 158.175(c)(3).

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The upper and lower certified limits, which must be proposed in connection with a product's registration, represent the amounts of an ingredient that may legally be present 40 CFR 158.175. The lower certified limit is used as the enforceable lower limit for the product composition according to FIFRA section 12(a)(1)(C), while the nominal concentration appearing on the label would be the routinely achieved concentration used for calculation of dosages and dilutions.

The nominal concentration would in fact state the greatest degree of accuracy that is warranted with respect to actual product composition because the nominal concentration would be the amount of active ingredient typically found in the product.

It is important for registrants to note that certified limits for active ingredients are not considered to be trade secret information under FIFRA section 10(b). In this respect the certified limits will be routinely provided by EPA to States for enforcement purposes, since the nominal concentration appearing on the label may not represent the enforceable composition for purposes of section 12(a)(1)(C).

III. REQUIREMENTS

As described below under Unit V. "COMPLIANCE SCHEDULE," all currently registered products as well as all applications for new registration must comply with this Notice by specifying the nominal concentration expressed as a percentage by weight as the label claim in the ingredient(s) statement and equivalence statements if applicable (e.g., elemental arsenic, metallic zinc, salt of an acid). In addition, the requirement for performing sample analyses of five or more representative samples must be fulfilled. Copies of the raw analytical data must be submitted with the nominal ingredient label claim. Further information about the analysis requirement may be found in the 40 CFR 158.170. All products are required to provide certified limits for each active, inert ingredient, impurities of toxicological significance(i.e., upper limit(s) only) and on a case by case basis as specified by EPA. These limits are to be set based on representative sampling and chemical analysis(i.e., quality control) of the product.

The format of the ingredient statement must conform to 40 CFR 156-Labeling Requirements For Pesticides and Devices.

After July 1, 1997, all pesticide ingredient statements must be changed to nominal concentration.

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IV. PRODUCTS THAT REQUIRE EFFICACY DATA

All pesticides are required to be efficacious. Therefore, the certified lower limits may not be lower than the minimum level to achieve efficacy. This is extremely important for products which are intended to control pests which threaten the public health, e.g., certain antimicrobial and rodenticide products. Refer to 40 CFR 158.640.

In those cases where efficacy limits have been established, the Agency will not accept certified lower limits which are below that level for the shelf life of the product.

V. COMPLIANCE SCHEDULE

As described earlier, the purpose of this Notice is to make the registration process more uniform and more manageable for both the agency and the regulated community. It is the Agency's intention to implement the requirements of this notice as smoothly as possible so as not to disrupt or delay the Agency's high priority programs, i.e., reregistration, new chemical, or fast track (FIFRA section 3(c)(3)(B)). Therefore, applicants/registrants are expected to comply with the requirements of this Notice as follows:

- (1) Beginning July 1, 1991, all new product registrations submitted to the Agency are to comply with the requirements of this Notice.
- (2) Registrants having products subject to reregistration under FIFRA section 4(a) are to comply with the requirements of this Notice when specific products are called in by the Agency under Phase V of the Reregistration Program.
- (3) All other products/applications that are not subject to (1) and (2) above will have until July 1, 1997, to comply with this Notice. Such applications should note "Conversion to Nominal Concentration" on the application form. These types of amendments will not be handled as "Fast Track" applications but will be handled as routine requests.

VI. FOR FURTHER INFORMATION

Contact Tyrone Aiken for information or questions concerning this notice on (703) 557-5024.

Anne E. Lindsay
Anne E. Lindsay, Director
Registration Division (H-7505)



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[REDACTED]

[REDACTED]

APPENDIX E
DATA CALL-IN

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EPA/600/2-89/053
September 1980

**INTERFERENCES AT PUBLICLY OWNED
TREATMENT WORKS**

by

Edward D. Wetzel and Scott B. Murphy
James M. Montgomery, Consulting Engineers, Inc.
Pasadena, California 91109

Contract No. 68-03-1821

Project Officer

Sidney A. Hannah
Wastewater Research Division
Water Engineering Research Laboratory
Cincinnati, Ohio 45268

**WATER ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268**

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
TECHNICAL SERVICE

000542

W 67262 1986

PB90-108853

Interferences at Publicly Owned Treatment Works

Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA

Prepared for:

Environmental Protection Agency, Cincinnati, OH

Sep 86

**U.S. Department of Commerce
National Technical Information Service**

DTIC

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TECHNICAL REPORT DATA

(If the report is not intended for the general public, please complete the following information.)

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Project Officer: S. A. Hannah (513-569-2621; FTS: 684-2621)

15. ABSTRACT
The discharge of heavy metals, toxic organics and variable strength conventional pollutants from industrial (and other non-domestic) sources can have negative impacts on the operation of publicly owned treatment works (POTW). Such industrial discharges can result in an interference at POTW, recently redefined by the U.S. Environmental Protection Agency (EPA) to mean "...causation of a POTW's noncompliance with its permit or inability to lawfully use or dispose of its sludge." This EPA funded study considers the sources of and contaminants causing interference, the impact on the POTW, and the mitigation techniques available for interference prevention. The approach to the study involved a review of the technical literature published during the last 5 years, a telephone survey of all state environmental agencies and identified municipalities, and site visits to nearly 30 POTWs that have been successful in their attempts to mitigate interference problems. The results of the study indicate that interference effects can be minimized with an effective program that combines the following elements: technically sound and enforceable industrial waste permits for all significant discharges, comprehensive monitoring of industrial discharges and POTW plant influent, the ability to track plant upset to the source of the discharge, and in-plant operational control to mitigate the impact of industrial wastes on POTWs. Information in this work document was condensed into a "Guidance Manual for Preventing Interference at POTWs" (September 1987) distributed by U.S. EPA, Office of Water Enforcement and Permits, 401 M. St. SW, Washington, DC 20460.

KEY WORDS AND DOCUMENT ANALYSIS

DESCRIPTIONS	IDENTIFIERS/OPEN ENDED TERMS	COSATI FWD/Group

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APPENDIX A
INTERFERING SUBSTANCES

CONVENTIONAL AND INORGANIC

Alkalinity
Ammonia
Biochemical Oxygen Demand
Chemical Oxygen Demand
Chloride
Fats, Oil and Grease
Iodine

Iron Salts
Nutrients
pH
Sulfate
Sulfide
Surfactants
Suspended Solids

METALS

Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Cyanide
Iron
Lead

Magnesium
Manganese
Mercury
Molybdenum
Nickel
Selenium
Silver
Sodium
Tin
Vanadium
Zinc

AGRICULTURAL CHEMICALS

Aldrin/Dieldrin
Chlordane
Chlorophenoxy Herbicides
DDT
Endrin
Heptachlor

Lindane
Malathion
Organometallic Pesticides
PCBs
Toxaphene

AROMATICS

Benzene
Chlorobenzene
Dichlorobenzene
Hexachlorobenzene

Nitrobenzene
Toluene
Xylene

HALOGENATED ALIPHATICS

Carbon Tetrachloride
Chloroform
Dichloroethane
Dichloroethylene
Dichloropropane
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclohexane
Hexachloroethane

Methylene Chloride
Tetrachlorodibenzodioxins
Tetrachlorodibenzofurans
Tetrachloroethane
Tetrachloroethylene
Trichloroethane
Trichloroethylene
Vinyl Chloride

NITROGEN COMPOUNDS

Acetanilide
Acetonitrile
Acrylonitrile
Aniline
Benzidine
Benzonitrile
Chloroaniline
Dichlorobenzidine
Dimethylnitrosamine

Dyes
EDTA
Ethylpyridine
Fluorenamine
Hydrazine
Nitrosodiphenylamine
Pyridine
Trisodium Nitrilotriacetate
Urea

OXYGENATED COMPOUNDS (Acids, Alcohols, Aldehydes, Esters, Ethers, Ketones)

Acetone
Acrolein
Adipic Acid Esters
Allyl Alcohol
Benzoic Acid
Boric Acid
Butanol
Butyl Benzoate
Chlorobenzoate
Chloroethyl Ether
Cinnamic Acid
Crotonol
Cyclohexanecarboxylic Acid
Diethylene Glycol
Ethoxy Ethanol
Ethyl Acetate

Ethylene Glycol
Formaldehyde
Formic Acid
Heptanol
Hexanol
Isophorone
Linoleic Acid
Malonic Acid
Methanol
Methylethyl Ketone
Methylisobutyl Ketone
Octanol
Polyethylene Glycols
Polyvinyl Alcohols
Protocatechuic Acid
Syringic Acid

PHENOLS

Catechol
Chlorophenol
Cresol
Dichlorophenol
Dinitrophenol
Nitrophenol

Pentachlorophenol
Phenol
Trichlorophenol
Trinitrophenol
Vanillin

PHTHALATES

Dimethylphthalate
Dioctylphthalate
Ethylhexylphthalate

POLYNUCLEAR AROMATIC HYDROCARBONS

Anthracene
Benzo (a) Anthracene
Chloronaphthalenes

di-Isopropylnaphthalene
Naphthalene
Pyrene

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APPENDIX C
CASE STUDY REPORTS

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Patapsco (Baltimore, MD)	169
Raeford, NC	172
Neuse River (Raleigh, NC)	175
Horse Creek (North Augusta, SC)	178
North Shore (Gurnee, IL)	181
Rockford, IL	184
Lake Mills, IA	187
Marshalltown, IA	189
Sioux City, IA	192
Newark, OH	195
1st Avenue (Phoenix, AZ)	198
Tolleson, AZ	201
Victor Valley (Victorville, CA)	204
Duck Creek, Paw Paw (Denison, TX)	207
Paris, TX	211
Post Oak (Sherman, TX)	214
Newberg, OR	216
Metro (Seattle, WA)	219

BAYSHORE REGIONAL SEWERAGE AUTHORITY
Union Beach, New Jersey

The Bayshore Regional Sewerage Authority (BRSA) operates an activated sludge treatment facility whose performance is largely dictated by a single industrial waste discharger. Three manufacturers of flavors and fragrances (one of whom is a perfume retailer) represent the total industrial wastewater flow of 325,000 gpd, or less than 5 percent of the POTW total. All three industries discharge high concentrations of conventional pollutants and routinely violate the maximum allowable monthly concentration limits for BOD (500), COD (1500) and TSS (500) as specified in their industrial waste permits. Two of the three manufacturers contribute less than 0.5 percent of the POTW flow, hence their impact is minimal. However, one building of the largest industry produces in excess of 200,000 gpd of wastewater with the following characteristics (in mg/l):

Parameter	1984			October 1985		
	Ave.	Monthly High	Monthly Low	Ave.	Daily High	Daily Low
BOD	1004	3054	245	2624	5250	522
COD	3238	4998	1440	7084	11380	2520
TSS	776	1835	94	1113	1698	672

The large variation in wastewater quality indicates that an activated sludge pretreatment system located at the industry at times produces a suitable effluent, but is obviously not sufficient to meet the fluctuating demands of their process wastes.

The potential impact of such an industrial discharge is evident when analyzing Figure C-1. The bar graph represents the percentage of total BOD being contributed by the industry on a daily basis. The upper plot on the line graph corresponds to the mass BOD loading, with the industry's contribution plotted beneath. This graph clearly demonstrates that the effluent from this single industry has increased the BRSA plant loading above the design limit of 15,000 pounds of BOD per day.

The BRSA has been particularly aggressive in their dealings with the industry in question. Since the manufacturer is not a retailer, adverse publicity has little effect, particularly since the industry is the largest employer in town. Consequently, the BRSA has taken a two-pronged approach:

- notification of violation and intent to pursue fines with a subsequent discontinuation of service if noncompliance persists after 30 days, and
- legal action to recover \$1.25 million in back surcharge payments and costs.

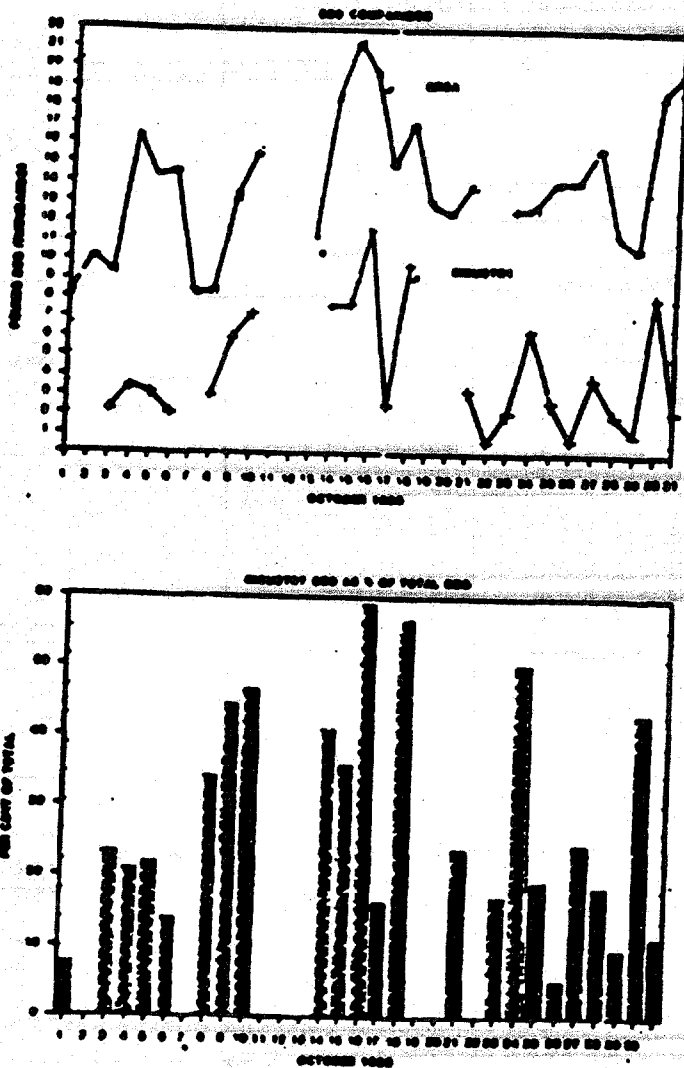


Figure C-1
Impact of Industrial Waste Discharge on POTW Loadings
October 1985

A similar approach proved successful during the 1960's, when the Keansburg, NJ water treatment plant was pumping the contents of their backwash water storage tank into the sewer system approximately twice per year. In the absence of an industrial wastewater permitting system, the BRSA's only recourse was to take the Keansburg authority to court and have them disconnected until a backwash recycle system could be installed at the water treatment plant.

BAYSHORE REGIONAL SEWERAGE AUTHORITY Union Beach, New Jersey

Design Flow: 8.0
Secondary Treatment: Activated Sludge (Modified Cyclic Stabilization)
Location: Eastern shore
Population Served: 85,000

INFLUENT WASTEWATER

Avg. Flow, mgd 6.4
% Industrial 5
SOD₅, mg/l 220-350
SS, mg/l 250-400

SIGNIFICANT INDUSTRIES

Industry: Flavors & Fragrances (Industrial)
Processes (1000 gpd): 125
Problem Pollutants: SOD, TSS, COL

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sd/day
Detention Time, hours
Effluent SOD₅, mg/l
Effluent SS, mg/l

Typical (0 speed)

825
1.75
150-250
150-200

Aeration Basins

F/M, lbs BOD₅/lbs MLSS/day
MCRT, days
MLSS, mg/l
Return Flow, %
Detention Time, hours
Control
Respiration

Typical (0 speed)

0.45 (1.25)
8-10
2000-2500
25

Secondary Clarifiers

Overflow Rate, gal/sd/day
Detention Time, hours
SVI, ml/gm

Typical (0 speed)

500
2.35
125 (>400)

PLANT PERFORMANCE

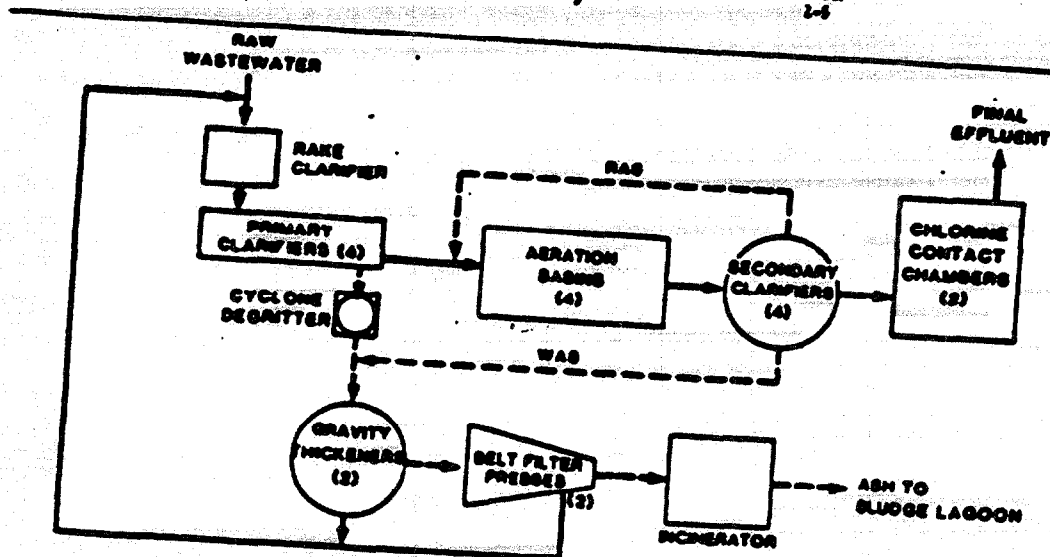
SOD₅, mg/l
SS, mg/l
D.O., mg/l

Permit Limit

30
30
5

Typical (0 speed)

35 (400)
27 (20)
2-5



HAMILTON TOWNSHIP WASTEWATER TREATMENT PLANT Trenton, New Jersey

The Hamilton Township Wastewater Treatment Plant (HTWTP) is an unusual facility in that plant upgrades over the past 30 years have been constructed as parallel flow processes rather than as replacements for older, outdated technology. Although this results in a complicated plant schematic (see below), parallel flow paths do provide operational flexibility and an opportunity to study the impact of a combined industrial/domestic wastewater on different fixed-film biological treatment processes. The HTWTP has had a difficult time meeting its permit limit for BOD over the past few years, and is currently under a Consent Order and Agreement and Compliance Schedule from the State Department of Environmental Protection.

Despite being at just over 50 percent of the plant's hydraulic capacity, Hamilton Township has experienced organic overloads, resulting in at least partial failure of 15 of the 48 RBC units. With the advent of an Industrial Waste Monitoring Program as part of a Sewers and Sewage Disposal Ordinance, the reasons for such overloading became apparent. Although the industrial waste program is still in its infancy, observations and analytical data have identified a pharmaceuticals manufacturer as a significant and potentially harmful discharger to the POTW.

Dating back to the summer of 1984, high concentrations of volatile organics were being discharged to the POTW on a once or twice-per-week basis. A monitoring program at the HTWTP uncovered an increase in influent BOD from 150 to 350-500 mg/l and high atmospheric levels of organic constituents with this discharge pattern. The specific industry was identified when a high influent pH reading lead Hamilton Township personnel to the pharmaceuticals manufacturer in March, 1985. Sampling conducted at that time detected significant levels of ethyl benzene, toluene and xylene in the industry's effluent. These findings precipitated an extensive testing program by the Township, with an independent engineering study conducted by the industry. The results indicated a correlation between the pharmaceutical discharges and high influent soluble BOD at the POTW. Analyses conducted on the industry's flow streams resulted in the following calculated average effluent concentrations:

Parameter	Concentration (mg/l)
Arsenic	2.6
Phenols	25.7
Total Toxic Volatile Organics (TTVO)	1.3
BOD	21,800
TSS	557
TDS	65,800

Based on an average flow of 15,000 gpd, these wastewater characteristics should not be harmful to an 8.5 mgd facility if discharged on a steady basis. It is the intermittent discharge of this wastewater which has contributed to the overloading of the biological population of the POTW.

During a three week shutdown of the industry in July of 1985, the HTWTP recovered to the point of meeting their permit limits. Consequently, the Township only permitted the industry access to the sewer system after the installation of metering pumps to equalize flows. This requirement initially improved POTW performance during the Fall of 1985, but a gradual deterioration in effluent quality (indicating possible toxicity effects) lead the Township to terminate service to the industry in late-November.

While the most recent action is being challenged, the industry is constructing an anaerobic pretreatment facility on site which should reduce the financial impact of a surcharge to be instituted with the next version of the industrial waste management program.

A number of operations and personnel changes have been instituted at the HTWTP to help mitigate the impact of the industrial discharges. These changes include:

- installation of aeration equipment in the influent channels to the RBCs to increase the first stage DO to 2-3 mg/l;
- extensive use of sludge judges and visual monitoring to augment reliance on control room instrumentation;
- performance of bioassay testing by an independent contractor to assess toxicity effects;
- purchase of a toxicity tester to be used in calculation of local limits for toxic contaminants; and
- hiring of four more people plus the purchase of a vehicle for an extensive industrial sampling program.

At this time, only a few industries have been sampled to any degree. One of the electroplaters in town was discovered with up to 60 mg/l of cadmium and 160 mg/l of chromium in their wastewater. Although pretreatment has not been installed, conservation efforts on the part of the industry has reduced their discharge from 14,000 to under 10,000 gpd.

SAMELTON TOWNSHIP WASTEWATER TREATMENT PLANT Trenton, New Jersey

Design Flow:
Secondary Treatment:

16 mgd
Trickling Filter and RSC

Location:

Population Served:

Central Western Border
87,000

INFLUENT WASTEWATER

Ave. Flow, mgd
% Industrial
BOD₅, mg/l
SS, mg/l

Typical (Upset)
4.5
25,000
200 (150)
100 (400)

Industry

Pharmaceutical
Electroplating (2)

SIGNIFICANT INDUSTRIES

Flowrate
(1000 gpd)

15
100

Problem Pollutants

BOD, phenol, ethyl benzene, toluene, xylenes
Cd, Cr, Zn, Ni

Primary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)
830, 100, 120
1.0, 4.0, 4.0

Trickling Filters

Plant Flow (mgd)
Hydraulic Loading, gal/sf/day
Organic Loading, lbs BOD/1,000 sf/day
Return Flow, %

Typical (Upset)
2.5, 1.0
100, 210
15, 10 (30)
20, 0.00

Secondary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)
520, 100, 200
2.0, 4.0, 4.0

RSCs

Plant Flow (mgd)
First Stage Organic
Loading, lbs BOD/1,000 sf/day
- Total
- Soluble

Typical (Upset)
5.0
5.3 (10.0)
1.5 (6.7)

PLANT PERFORMANCE

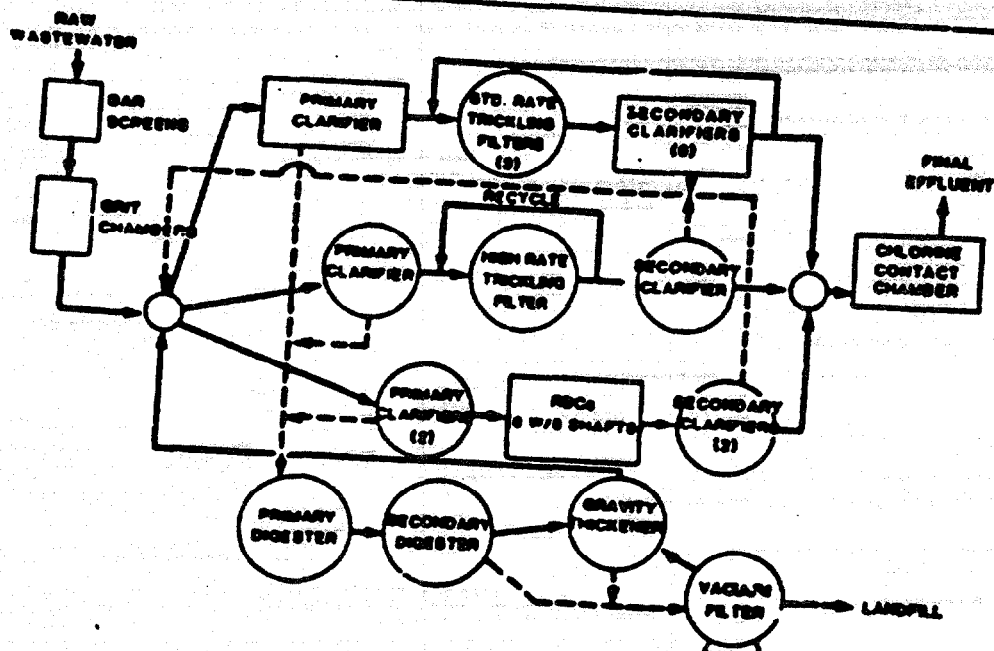
BOD₅, mg/l
% BOD₅
NH₃-N, mg/l (Effective 6/84)

Permit Limit

30
30
10

Typical (Upset)

65 (130)
20 (50)
20 (30)



PASSAIC VALLEY WASTEWATER TREATMENT PLANT

Newark, New Jersey

Coping with industrial waste discharges to a 300 mgd POTW in a highly industrialized area is a challenging task. The Passaic Valley Sewerage Commissioners (PVSC) maintain an industrial waste control staff to monitor nearly 400 industries that contribute 20 percent of the wastewater volume and 50 percent of the waste strength. The PVSC performed their first Industrial Waste Survey for database development in 1972, and adopted a set of Rules and Regulations (including local limits) in 1976. By 1982, a comprehensive system consistent with the Federal Clean Water Act of 1977 had been adopted, which established uniform user fees for mass and volumetric loadings in the Passaic Valley plant.

The influent wastewater to the POTW is considered a high-strength waste, with typical BOD and TSS values of 290 and 450 mg/l, respectively. Despite the strength of the influent, the plant is close to meeting the 30/30 NPDES discharge limits, even though the primary clarifiers are not scheduled to go on-line until later this year (1986). The PVSC believes that the addition of primary treatment coupled with the economic incentives for pretreatment created by the user charge system will reduce the effluent to consistently below the limits.

The individual constituents of concern to the PVSC fall into three general categories:

- metals
- flammables
- fibers

The sources of heavy metals are chemical manufacturers, platers and tanneries. One of the smaller (30,000 gpd) chemical companies had been identified as a significant contributor (120 lbs/day) of mercury to the POTW. Although the mercury level of 50 ug/l at the influent was not inhibitory to the activated sludge, the concentration of mercury in the sludge limited the municipality's disposal options. It is anticipated that ocean disposal of sludge will not be permitted much longer, which will require the PVSC to incinerate. The Federal Air Pollution Standards limit the mercury discharge to 3,200 g/day, which translates into a local limit of 0.4 lbs/day in the wastewater from the industry in question. The chemical company responded by isolating the relevant process streams and utilizing a batch recovery system for the mercury, reducing the discharge from 120 down to 5 lbs/day. When ocean disposal is formally eliminated as a disposal option, the company can employ carbon treatment for removal of the remaining mercury.

The oxidation of trivalent chromium to the hexavalent form in a POTW sludge incinerator is a problem caused by the chromium-laden discharge from various industrial users. An additional problem caused by the tanning industrial category is the clogging of local sewers that results from hides being inadvertently discharged from the companies. Similar clogging problems existed at the pretreatment plant due to the balled-up fibers from the pulp and paper

manufacturers which close off sludge return lines, orifices and nozzles. This condition improved substantially when the moving-bridge primary clarifiers were placed in service in December, 1985.

The Passaic Valley plant had a unique problem with high concentrations of flammable materials in the influent wastewater. The lower explosive limit (LEL) is defined as the "lowest concentration of a combustible substance in air through which a flame, once ignited, will continue to propagate". When a wastewater approaches 50 percent of the LEL, it is important that it not be discharged into the sewer collection system. The pure oxygen process has a control built into the system which vents all oxygen away from the activated sludge treatment process when high LEL is detected. Since the venting of the oxygen reduces the treatment efficiency and can result in a permit violation, such discharges are not only health hazards, but interferences as well.

The PVSC instituted a three-part program in October of 1984 to mitigate the problems of flammables:

- required industries using or manufacturing solvents which come in contact with discharged wastewater to install LEL detection instruments, and to provide pretreatment to isolate the flammables if high LELs were detected;
- surveyed other industries which used solvents but had no such discharge to determine if a potential existed, requiring necessary control mechanisms; and
- monitored the collection system more closely for illegal dumping of such chemicals.

Representatives of Passaic Valley made it clear that a cooperative attitude on the part of industry was an important factor in successful mitigation of interference problems. In fact, it was the local pharmaceutical manufacturer that conducted the research resulting in the type of LEL instrument recommended by the Advisory Committee when the LEL regulation was adopted.

PASADENA VALLEY WASTEWATER TREATMENT PLANT Pasadena, New Jersey

Design Flow:
Secondary Treatment:

250 mgd
Activated Sludge
(Pure Oxygen)

Location:

Population Served:

Adjacent to Newark Bay
1.5 million

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	150
% Industrial	10
BOD ₅ , mg/l	200-500
SS, mg/l	450-750

SIGNIFICANT INDUSTRIES

Industry	Flowrate (mgd)	Problem Pollutants
Pulp and Paper 'D'	10.3	Fibers
Pharmaceuticals	5	Xylenes, Toluene, Hexane
Tanneries 'H'	1.5	Cr
Chemicals 'J'	0.3	Ca, Cr, Hg, Pb

PLANT LOADING

Primary Clarifiers
Overflow Rate, gal/sd/ft²
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)

1,100
2.0
225
125

Aeration Basins

F/M, lbs BOD₅/lbs MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)

0.6
5
2,000
1.0
35
4-12

Secondary Clarifiers

Overflow Rate, gal/sd/ft²
Detention Time, hours
SVI, ml/gm

Typical (Upset)

400
5
65

PLANT PERFORMANCE

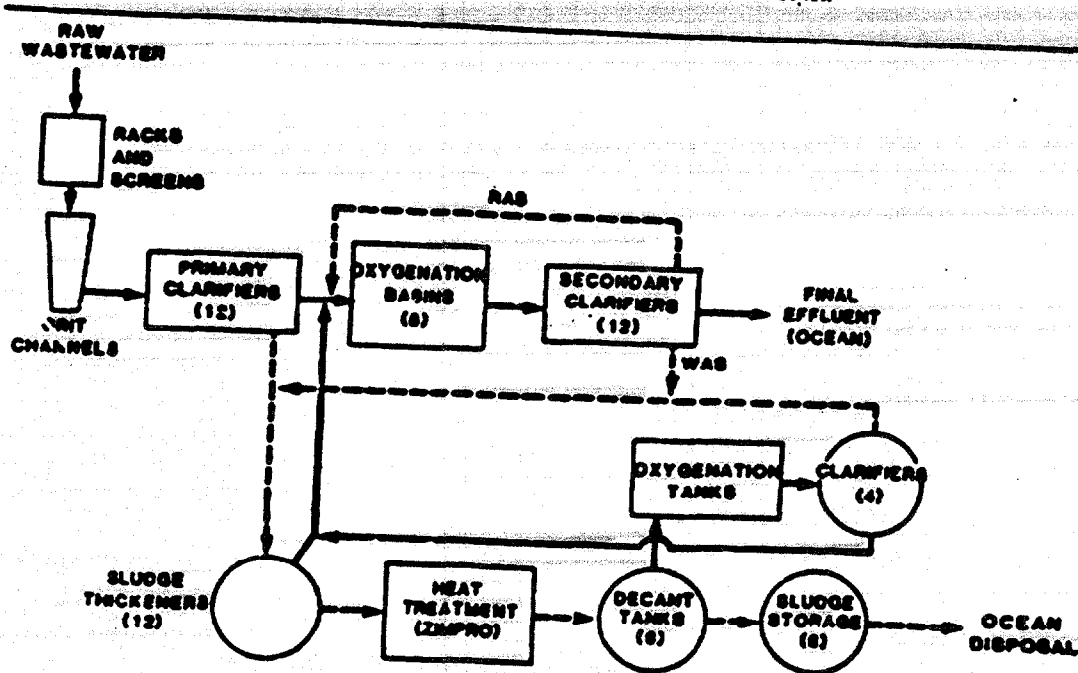
BOD₅, mg/l
SS, mg/l

Permit Limit

30
30

Typical (Upset)

25-100
25-100



BINGHAMTON-JOHNSON CITY JOINT SEWAGE TREATMENT PLANT
Binghamton, New York

In 1981, the Binghamton-Johnson City Joint Sewage Treatment Plant had to terminate landspreading of sludge because the sludge did not meet the cadmium criteria established by the New York State Department of Environmental Conservation (NYDEC) for such disposal. A paper coating industry in Binghamton was the only identified industry that used and discharged high concentrations of cadmium. The industry cooperated with the Joint Sewage Authority and reduced their cadmium discharge levels by installing a pretreatment system that utilizes ammonia stripping followed by metal precipitation. During the 1975-1979 period, cadmium levels in the sludge from the Joint Sewage Treatment Plant were in the range of 100 to 150 mg/kg. In 1982, the level was reduced to 53 mg/kg, and presently the level is at 15 mg/kg. The cadmium limit imposed by the NYDEC for land spreading of the sludge is 25 mg/kg. The treatment plant is presently landfilling sludge but intends to install sludge composting equipment in the future.

There are approximately twelve significant industries contributing flow to the Joint Sewage Treatment Plant. There are several electroplaters who discharge metals, (other than cadmium), to the plant. Most of the electroplaters have installed pretreatment equipment in order to comply with industry categorical standards. The Binghamton-Johnson City Joint Sewage Board adopted rules and regulations effective March 1, 1985 that gave the board direct control over industrial wastewaters discharged to the sewage treatment plant. In the near future the Joint Sewer Board will issue industrial discharge permits in order to enforce local limits which will be set to ensure compliance with state water quality standards, (which are presently being revised), and sludge disposal criteria. At the present time, chromium, zinc and nickel concentration levels in the sludge occasionally approach or exceed the NYDEC landspreading limits. The imposition of local industrial waste discharge limits are expected to result in reduction in metal levels in the sludge to acceptable levels.

The Joint Sewage Treatment Plant has had consistent operational problems associated with biosolids losses from the secondary clarifiers. The poor operation of the clarifiers has been due to severe short circuiting as well as hydraulic surges from infiltration/inflow and stormwater flows. The Joint Sewage Board is presently undertaking corrective action to alleviate the problem. The secondary clarifiers are being modified by the addition of new influent baffling and the relocation of the effluent weirs. The reduction of infiltration/inflow and stormwater flows into the plant will be reduced by extensive sewer system rehabilitation.

000558

BRONXTON - JEROME CITY JOINT SEWAGE TREATMENT PLANT BRONXTON, NEW YORK

Design Flow:
Secondary Treatment:

10 mgd
Activated Sludge
(Completely Mixed or
Imhoff Stabilization)

Location:
Population Served:

Central New York
124,000

INFLUENT WASTEWATER

	Typical (mgd)
Ass. Flow, mgd	20
% Industrial	1
BOD ₅ , mg/l	210
SS, mg/l	210

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Potentials
Paper Coating	200	Cellulose
Electroplating	10	Zinc, Nickel, Cyanide

PLANT LOADS

Primary Clarifiers
Overflow Rate, gal/sq-ft/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (mgd)
1,500
2
125
70

Aeration Basins
MCRT, days
MLSS, mg/l
Solids Retention Time, hours
SRT, hours

Typical (mgd)
2-3
2,500
2

Secondary Clarifiers
Overflow Rate, gal/sq-ft/day
Detention Time, hours
SVI, ml/gm

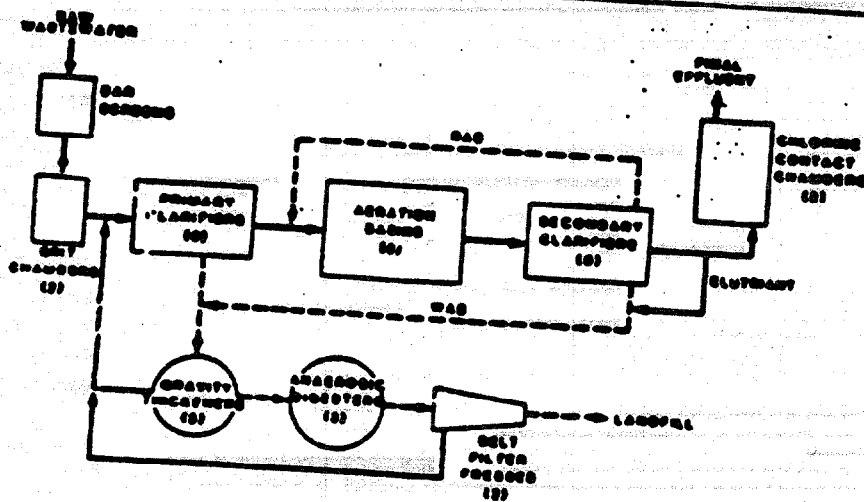
Typical (mgd)
500
2.5
170

PLANT PERFORMANCE

	Typical (mgd)
BOD ₅ , mg/l	55
SS, mg/l	55
Percent Solids Recovered	90
Percent Solids Recovered of Year	90

SOLIDS METAL CONCENTRATION

	1982 Level	1983 Level
Lead, mg/kg	25	100
Cadmium, mg/kg	1,000	50
Chromium, mg/kg	200	210
Nickel, mg/kg		50



CITY OF CANANDAIGUA WASTEWATER TREATMENT PLANT
Canandaigua, New York

During its first year of operation, the City of Canandaigua Wastewater Treatment Plant failed to meet its NPDES Permit limits for BOD and Ultimate Oxygen Demand (UOD)* approximately half of the time. Violations were due to high influent organic loads from a winery in the city. In 1982, the winery discharged an average flow of 100,000 gpd having a BOD concentration of 3,500 mg/l. This was in violation of the discharge limitations that were in effect for the winery under the sewer use ordinance. The pretreatment limits for the winery had been set at the following concentrations:

COD	600 mg/l
BOD	300 mg/l
Suspended Solids	350 mg/l
Total Kjeldahl Nitrogen	55 mg/l
Phosphorus	10 mg/l

The City of Canandaigua initiated court action against the winery in early 1983 for violations of the sewer use ordinance. Subsequently, the city and winery agreed out of court on a compliance schedule for the winery.

The limits in the sewer use ordinance will be integrated into the industrial discharge permit that will be issued to the winery in the near future. The winery expanded its pretreatment facility and in 1984 its discharge had an average BOD concentration of 400 mg/l. The City of Canandaigua Wastewater Treatment Plant operation has improved dramatically as its effluent met its discharge permit requirements for all of 1984.

The City of Canandaigua Wastewater Treatment Plant uses air driven rotating biological contactors (RBCs) for carbonaceous organics removal followed by nitrification. In 1982, the RBCs were not effectively removing CBOD or ammonia from the wastestream because of excessive organic overloading from the winery. In addition, the organic overload caused excessive growth on the RBCs resulting in inadequate rotation of the units. During 1982, up to half of the RBCs were not operational.

The winery, which is the only major industry in the city, had increased production and was overloading its existing pretreatment facility in 1982. As a result of the agreement in early 1983 that set a compliance schedule, an expansion of the winery's pretreatment facility was on line by late 1983. Both the original and expanded pretreatment systems utilize an extended aeration activated sludge process for organic concentration reduction. The winery's expanded pretreatment facility has experienced problems with filamentous

* $UOD = (1.5 \times CBOD_5) + (4.5 \times TKN)$, where $CBOD_5$ is the five day carbonaceous biochemical demand and TKN is total nitrogen.

organism growth in its sludge. The winery is attempting to control this problem through chlorination. The City of Canandaigua Wastewater Treatment Plant has not experienced problems with sludge bulking in their secondary clarifiers. Generally RBC sludge does not tend to bulk and additionally the use of ferric chloride for phosphorus removal prior to secondary clarification further enhances sludge settleability. Bulking of the sludge has occasionally occurred, however, in the city's sludge gravity thickeners. The winery periodically exceeds its organic discharge limits due to pretreatment plant upsets. When this occurs simultaneously with inflows of leachate and septic tank waste from truckers, a slight reduction in gas production from the city's anaerobic digestors has been noted.

CANANDAIGUA WASTEWATER TREATMENT PLANT **CANANDAIGUA, NEW YORK**

Design Flow:
 Secondary Treatment: 4.5 mgd
 Rotating Biological
 Contactors

Location:
 Population Served: Central New York State
 21,000

INFLUENT WASTEWATER

	Typical (Upset)
Avg. Flow, mgd	1.3
% Industrial	3
B.C., mg/l	100-160
SS, mg/l	230

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Potentials
Winery	100	BOD, COD

PLANT LOADINGS

Primary Clarifiers

Overflow Rate, gal/sd/day
 Detention Time, hours
 Effluent BOD₅, mg/l
 Effluent SS, mg/l

Typical (Upset)

800
 2.7
 150 (230)
 80

Rotating Biological Contactors

Oxygen Loading, lbs BOD₅/1,000 sfd
 Hydraulic Loading, gal/sd/day
 Carbonaceous Contactors
 Nitrification Contactors

Typical (Upset)

1.5 (2.0)
 2.5
 1.6

Secondary Clarifiers

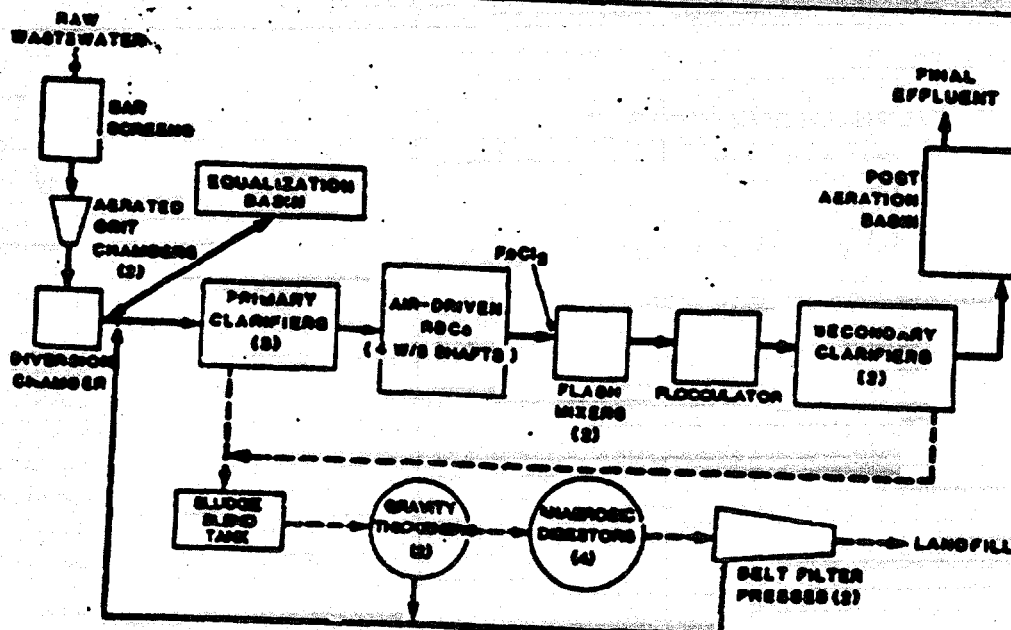
Overflow Rate, gal/sd/day
 Detention Time, hours

Typical (Upset)

600
 3

PLANT PERFORMANCE

	Peak Load	Typical (Upset)
BOD ₅ , mg/l	30	11 (45)
SS, mg/l	35	11
COD, mg/l		
Summer and Fall	91.7	31 (74)
Spring	97.6	22 (140)
Winter	134.0	35 (73)



EAST SIDE SEWAGE TREATMENT PLANT

Oswego, New York

The City of Oswego, East Side Treatment Plant has experienced significant non-compliance problems associated with the loss of solids from their secondary clarifiers. Half of the plant's hydraulic flow is from a paper mill which is the only major industry in the city. From 1981 to 1983, the noncompliance problems at the plant were attributed to severe hydraulic and organic load peaks from the paper mill as well as operational difficulties such as frequent breakdowns of the return sludge pump drives. It is not known whether filamentous growth in the sludge occurred at that time. In 1983 the paper mill voluntarily reduced the hydraulic and organic peaks to the plant. Solids losses from the secondary clarifier still remained a problem. During 1984, the plant frequently exceeded their NPDES discharge suspended solids by five times the limit and the BOD by three times the limit. During that period, the plant still occasionally received hydraulic peaks from the paper mill which were twice the average rate for two to three hour periods, but a substantial cause of the problem was identified as poor sludge settleability due to filamentous growth. The frequent washout of biosolids from the secondary clarifiers resulted in a low mean cell residence time and the generation of a young sludge that did not settle well. In the spring of 1985, the belt drives on the return sludge pumps which had frequently been out of service were replaced with electronic variable speed drives. This improvement allowed the plant operators to maintain better control of the solids inventory in the aeration tanks. Plant performance was still poor, however, because of sludge bulking.

Several measures have been taken at the plant in an attempt to alleviate the sludge bulking problem. The measures that were taken are:

- switching from plug flow feed to a step feed in the aeration tanks in order to achieve better dissolved oxygen distribution;
- varying process control strategies such as sludge return and wasting rates, and sludge blanket depth; and
- chlorination of the return sludge for the destruction of filamentous growth in the sludge.

The step feed operation has resulted in better dissolved oxygen distribution but did not significantly improve sludge settleability. The second two mitigation efforts were ongoing at the time of writing. A chlorination dosage of 6 lb Cl_2 /1000 lb solids had been applied to the return sludge. Microscopic examination of the sludge indicated that the filaments had shrunk and the SVI level had dropped to the range of 60-80. The plant operators intend to chlorinate whenever the SVI increases to 150. It has not been determined if these mitigation measures can result in plant performance that will consistently meet the permit discharge limits.

The paper mill periodically discharges slugs of waste containing high suspended solids to the treatment plant. At these times, the sludge in the primary tanks

takes on a gelatinous quality which makes sludge removal difficult. High periodic input of clay filler materials from the paper mill has resulted in poor sludge incineration with associated high fuel usage.

The City of Oswego is presently preparing an industrial discharge permit for the paper mill. The permit will restrict the monthly and daily average BOD and suspended solids levels in the influent from the paper mill as well as restrict the daily maximum hydraulic peak allowed. Under the permit provisions the paper mill will be required to submit listings of the chemicals used in their processes. The paper mill is presently voluntarily investigating the possible relationship of the chemicals used in their manufacturing processes to the occurrence of filamentous growth in the activated sludge process.

LAKE ERIE SEWAGE TREATMENT PLANT OWEGO, NEW YORK

Design Flow
Secondary Treatment:

3 mgd
Plug or Step Feed
Activated Sludge

Location:

Population Served:

Northway New York
10,000

INFLUENT WASTEWATER

	Typical (Upset)	Industry
Ave. Flow, mgd	2.5	Paper Mill
% Industrial	50	
	Municipal	Paper Mill
BOD ₅ , mg/l	120	100
SS, mg/l	120	400 (1000)

SIGNIFICANT INDUSTRIES

Flowrate (1000 gpd)	Problem Pollutants
1,300	SS, BOD

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sq/ft/day
Detention Time, hours

Typical (Upset)

	Municipal	Paper Mill
Effluent BOD ₅ , mg/l	70	120
Effluent SS, mg/l	40	100

Aeration Basins

F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)

0.2
7-10
2,000 (300)
7
25 - 45
2 - 4

Secondary Clarifiers

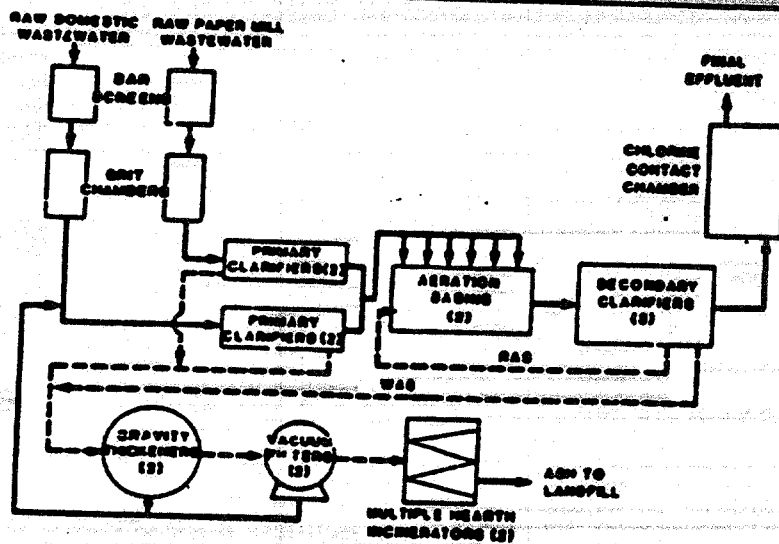
Overflow Rate, gal/sq/ft/day
Detention Time, hours
SVI, ml/gm

Typical (Upset)

600
2
100 (1000)

PLANT PERFORMANCE

	Permit Limit Remainder of Summer	Typical (Upset)
BOD ₅ , mg/l	10	20 (120)
SS, mg/l	10	25 (300)



HATFIELD TOWNSHIP ADVANCED TREATMENT FACILITY Colmar, Pennsylvania

The Hatfield Township Municipal Authority (HTMA) operates an advanced wastewater treatment facility which receives two-thirds of its domestic flow from Hatfield Township and one-third from Montgomery Township, Pennsylvania. Although less than 10 percent of the plant flow is supplied by industry, up to 60 percent of the influent waste strength can result from industrial and waste hauler sources. The HTMA was issued a Consent Order and Agreement by the Pennsylvania Department of Environmental Resources in March 1985 for non-compliance with their NPDES Permit due to hydraulic and organic overloading at the POTW. The Order gives the HTMA until May 1, 1987 to meet a new set of discharge limits, which, in addition to those shown on the attached data sheet, includes a 2/6 mg/l (summer/winter) ammonia limit. A new 6.4 mgd Shreiber process facility including nitrification/denitrification capability is currently under construction to meet the goals of the post-1987 permit.

Violations of the total phosphorus limit (2 mg/l) and occasional problems with the ammonia (32) and BOD (15, summer) limits are the primary reasons for the Consent Order. The advanced treatment facility has performed well enough in the area of suspended solids removal that pressure filters installed following the tube settlers in the flow schematic have been taken out of service. Feeding FeSO_4 to the return activated sludge improved the total-P removal from 43 percent to 65 percent, and is enough to consistently reduce the effluent P to below 2 mg/l.

While industrial discharges can not be blamed for exceeding the phosphorus limits, high influent BOD, SS and nitrogen are directly attributable to a few of the key industries. The Industrial Wastewater Discharge Permits issued by the HTMA limit the concentrations of these compounds to the following monthly averages (in mg/l):

<u>Parameter</u>	<u>Maximum</u>	<u>Surchargeable</u>
BOD	2,000	195
SS	800	180
TKN + NO_2 + NO_3	160	15
Total-P	20	8
FOG	250	

The most significant violator of the discharge limits is a 120,000 gpd industrial waste pretreatment facility that uses a physical-chemical process for metals removal and pH neutralization. The average effluent from this plant was measured in 1984 as:

BOD (soluble)	3109
SS	1718
Nitrogen	586
Total-P	7.7

Additionally, numerous organic compounds have been identified in their discharge with concentrations ranging from 10 to 5,500 ug/l, but no interference due to these organics has been detected to date. Given the nature of the wastewater, it is not surprising that the HTMA has denied a permit to the industrial waste pretreater for expansion of their facility. However, the feasibility of utilizing the existing POTW to treat larger volumes of this wastewater after the new municipal facility is on-line is now being evaluated.

A second significant contributor of conventional pollutants had been a 17,000 gpd dairy, who was being surcharged for excess BOD, SS and nitrogen. In this case, the solution was to truck the whey waste rather than discharge to the sewer, resulting in a cost savings to the dairy and reduced loadings at the POTW.

A small (1,500 gpd) chemical company was being surcharged \$ 10,630 per quarter for an ammonia discharge of up to 30,000 mg/l. At times, the NH_3 concentration at the POTW influent would reach 100 mg/l. In 1983, the industry installed a pretreatment system which reduced the NH_3 concentration, so that the company's quarterly surcharge now ranges from \$ 1,000 to \$ 1,500.

The HTMA permits 13 haulers of septage, holding tank contents and leachate to discharge 115,000 gpd into the effluent launder of the primary clarifiers. While this practice generated over \$ 350,000 of income in 1984, the impact of these discharges on the treatment plant are difficult to assess given the limited sampling of these wastewaters. A single day's testing of the discharges in April 1985 produced suspended solids results ranging from 23 to 65,000 mg/l, and COD values of from 800 to 36,000 mg/l. HTMA has estimated that the hauler wastewater increases the sludge production at the POTW by 40 percent over the volume generated by the influent wastewater.

BATFIELD TOWNSHIPS ADVANCED WASTE TREATMENT FACILITY COLMAR, PENNSYLVANIA

Design Flow:
Secondary Treatment: 1.6 mgd
Aerobated Sludge
(Complete Mix)

Location:
Population Served: Southwestern Pennsylvania
20,000

INFLUENT WASTEWATER

Typical (Upset)

Ave. Flow, mgd	1.6 (1.0)
% Industrial	10
BOD ₅ , mg/l	2.0 (3.50)
SS, mg/l	2.5 (3.00)
NH ₃ , mg/l	25 (30)

Industry

Ind. Waste Treatment	120
Dairy	17
Steel (Paint Shop)	25
Chemical	1.5
Waste Haulers (12)	115

SIGNIFICANT INDUSTRIES

Flowrate
(1000 gpd)

Problem Pollutants

BOD, SS, N, Organics
BOD, SS, NH ₃
Paint shops
NH ₃
COD, SS

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)

600 (1,000)
3 (1.7)
170
205

Aeration Basins

F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)

0.33
0.3
4,500-5,000
6 (2.2)
20
4

Secondary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours
SVI, ml/gm
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)

720 (1,100)
3 (1.7)
75
90
75

PLANT PERFORMANCE

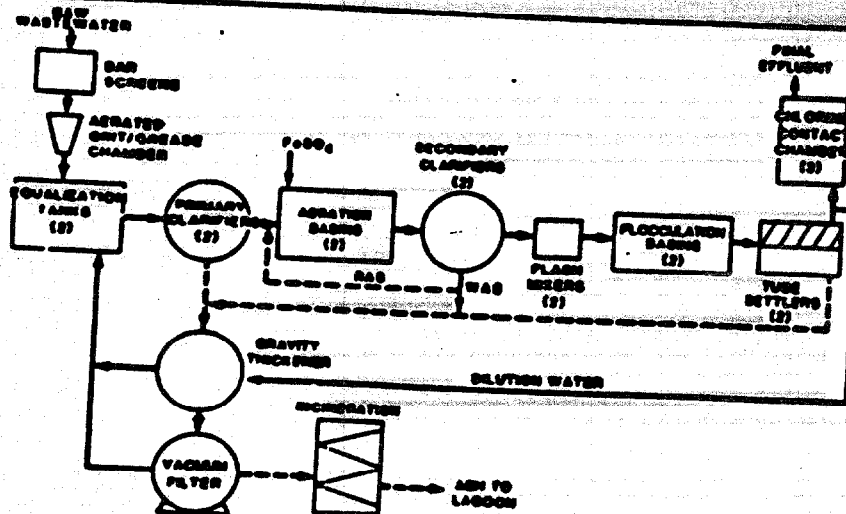
BOD₅, mg/l
SS, mg/l
NH₃, mg/l
NO₂ - NO₃, mg/l
Total-P, mg/l

Permit Limit

15/30
30
25
N/A
2

Typical (Upset)

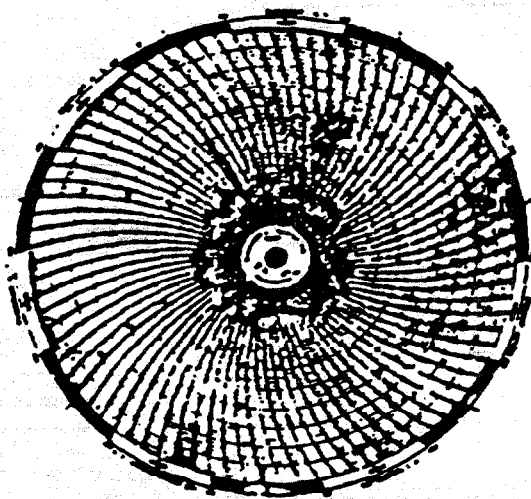
12 (20)
5 (10)
24 (40)
3 (6)
4 (20)



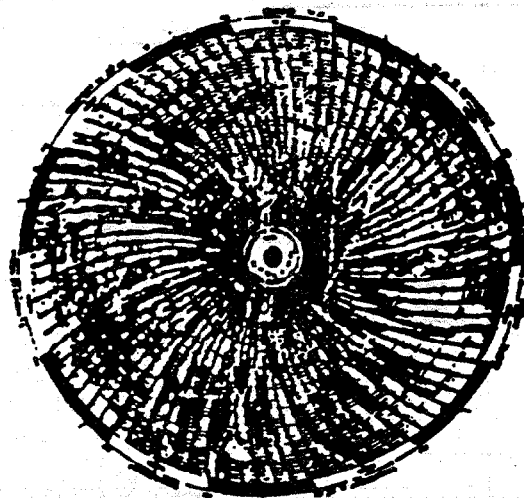
MAIDEN CREEK WASTEWATER TREATMENT PLANT Blandon, Pennsylvania

The Maiden Creek Wastewater Treatment Plant (MCWTP) went on-line in December, 1981 as a secondary treatment facility designed to remove both carbonaceous and nitrogenous BOD. The plant uses a patented aerated submerged fixed film biological treatment system, where flat asbestos plates hang vertically in the settled wastewater provide a growth surface for the bacteria. Each of three contact basins contains 320 plates with 200 sq. ft. of surface area. Oxygen is provided by fine bubble aeration through ceramic diffusers.

During the first six months of operation following an initial acclimation period, the MCWTP experienced gradual flow increases from 0.1 to 0.15 mgd while consistently meeting their permit limits. In August of 1981, a local mushroom processor began batch discharging high BOD wastewater to the POTW at flows sometimes exceeding 100 gpm. The hydraulic and organic shock loadings resulted in nitrifier washouts, solids carryover, reduced BOD removal efficiency and at times total biological process failure. Although the industry was not measuring their wastewater flow rates at that time, they were the only significant non-domestic contributor. After factoring out any potential infiltration/inflow from stormwater flows, the discharge pattern from the industry was obvious from an inspection of the weekly flow recordings at the POTW. Figure C-2 illustrates the dramatic effect of the industrial discharges on the MCWTP influent.



April, 1982



October, 1982

FIGURE C-2
WASTEWATER DISCHARGE AT INFLUENT METERING STATION (MGD)

As a result of significant time and effort on the part of Malden Creek Township Municipal Authority two years ago, the food processor installed a physical-chemical treatment system which included surge control tanks and aeration. The system did reduce the solids load and partially mitigated the flow spike problem, although the surge tanks were not capable of providing complete equalization. Unfortunately, the great percentage of their organic waste is soluble, so the pretreatment facility is ineffective in reducing the BOD loading to the POTW. Additionally, wastewater production far exceeds the 50,000 gpd limit imposed by their permit, so occasional flow spikes are still evident. The industry has requested nearly ten times the current flow limit, necessitating the design of a full secondary system to reduce their waste strength to domestic levels. Such a system, including a 650,000 gallon aerated equalization basin, is scheduled to go on-line in mid-1986. In the interim, the municipality has required that the industry:

- control flow surges;
- meter and record their flows continuously;
- reduce the BOD in the effluent by in-house methods; and
- composite sample their discharge on a regular basis.

Failure to comply with the abovementioned program will result in a shut off by the POTW, a measure used previously in February, 1985 when the industry's wastewater was responsible for total process failure at the plant.

A number of operational changes were instituted in May of 1985 to help combat the high organic loads in the contact basins. These changes included:

- increasing the aeration by using all blowers at the plant, resulting in an increase in the first stage D.O. from 2 mg/l to 5 mg/l;
- addition of selective strains of bacteria to increase the rate of BOD removal;
- recycling the plant effluent to the head of the plant to dilute the incoming wastewater; and
- reducing the allowable flow from the food processor and closely monitoring their adherence to the limits.

Since these changes were implemented concurrently, it is impossible to isolate the individual impacts of each operations change. However, the collective result was a substantially improved compliance record. There have also been no flow spikes at the POTW since mid-December, 1985, indicating better flow control on the part of the food processor.

MAIDEN CREEK WASTEWATER TREATMENT PLANT BLANDON, PENNSYLVANIA

Design Flow:	0.45 mgd	Location:	Southeastern Pennsylvania
Secondary Treatment:	Amoxicil Submerged Film Filter (Contact Aeration)	Population Served:	2,000

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	3.25
% Industrial	25 (1000)
BOD ₅ , mg/l	150 (1000)
SS, mg/l	200
NH ₃ , mg/l	60

SIGNIFICANT INDUSTRIES

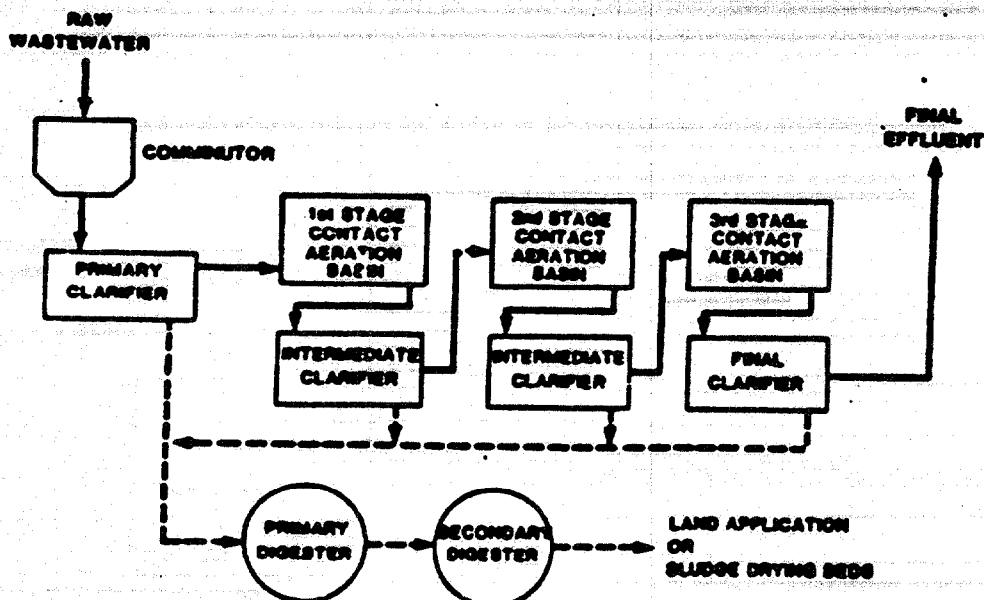
Industry	Process (1000 gpd)	Problem Pollutants
Food Processor Dental Office	10 negl.	BOD, Flow surges Hg

PLANT LOADINGS

Primary Clarifiers	Typical (Upset)	Contact Basins	Typical (Upset)
Overflow Rate, gal/sf/day	350 (1,000)	Organic Loading (lbs BOD ₅ /1000 sq ft/day)	2.4
Detention Time, hours	2.75 (1.25)	Total Plant	6.4
Effluent BOD ₅ , mg/l	140	First Stage	12
Effluent SS, mg/l	100	Detention Time, hours	5-10
		D.O. Level, mg/l	
Secondary Clarifiers	Typical (Upset)		
Overflow Rate, gal/sf/day	450 (1,300)		
Detention Time, hours	2.4 (1.0)		

PLANT PERFORMANCE

	Permit Limit	Typical (Upset)
BOD ₅ , mg/l	30	15 (400)
SS, mg/l	20	10 (100)
NH ₃ , mg/l	10/20	1 (40)



ROCKY CREEK WATER POLLUTION CONTROL PLANT Macon, Georgia

The Rocky Creek Water Pollution Control Plant (RCTP) treats an average of 12 mgd of wastewater, nearly half of which is contributed by industrial users. 40 percent of the total plant flow and 70 to 80 percent of the organic and solids loading is contributed by one paper products manufacturer. Additional major industrial users are an animal food processor, two food processors and a wood preserving plant. The RCTP has been in substantial non-compliance of its NPDES permit since coming on line in 1975, primarily because of variable discharge of high strength organic waste. Although industrial wastes continue to make up a large portion of the organic loading to the RCTP, the plant has not experienced a NPDES permit violation in the last six months, coinciding with the development and implementation of an industrial pretreatment program.

The RCTP utilizes the extended aeration activated sludge process to treat the high-strength domestic/industrial wastewater. The large organic contribution of the paper products manufacturer is nutrient deficient and requires phosphorus and nitrogen addition for proper biological treatment. Despite the large organic contribution and poor solids settling characteristics of this industrial wastestream, it has not historically presented chronic treatment problems because of its fairly consistent strength. Interferences identified at the RCTP were primarily attributed to the other major industrial users, in particular the animal food processor. Operations at the animal food processing plant were such that periodic slugs of organic wastes were discharged to the RCTP with COD values as high as 30,000 mg/l. Typical daily average RCTP influent organic and solids loadings were 350 mg/l BOD and 230 mg/l SS, but would rise as high as 525 mg/l and 500 mg/l, respectively, during upset periods. These stress conditions resulted in treatment plant organic overload and poorly settling sludge, with effluent BOD and SS levels rising to 80 mg/l and 150 mg/l, respectively. Oils and creosote from the wood preserving plant are not typically discharged in high enough concentrations to upset the biological treatment process on their own, but occasionally contribute to the magnitude of interferences during organic overloads by decreasing sludge settleability. Chlorine addition was used with some success to improve the settleability of the activated sludge.

To control a worsening problem, a pretreatment program was developed and final industrial wastewater discharge permits were issued in October, 1985 by the Macon-Bibb County Water and Sewerage Authority. In order to meet their permit limits, nearly all major industries have hired consultants to examine their pretreatment programs or have installed or upgraded existing pretreatment plants. The paper products manufacturer upgraded its existing stabilization pond by installing a new 15 million gallon clarifier, a thickener tank and belt press. The dewatered sludge is incinerated. The animal food processor modified a sump pump station in addition to constructing a new drain catch-basin. These modifications allow for the recovery of previously wasted sugar and molasses sludges and cause wastewater organic loadings to be significantly decreased, in addition to being equalized. The wood preserving operation installed a compact clarifier that recovers floatable oils and grease as well. The industrial

pretreatment improvements have been a major factor in the RCTP treatment improvements, as the plant has gone from being overloaded and upset 50 percent of the time to being upset twice a month at most. As a result, no NPDES permit violations have been experienced since September, 1985.

ROCKY CREEK WATER POLLUTION CONTROL PLANT Macon, Georgia

Design Flow:
 Secondary Treatment:

14 mgd
 Extended Aeration
 Activated Sludge

Location:
 Population Served:

Central Georgia
 71,000

INFLUENT WASTEWATER

Ave. Flow, mgd
 % Industrial
 BOD₅, mg/l
 SS, mg/l

Typical (Upset)

12
 10
 150-1525
 250-5000

Industry

Paper products
 Animal Feed processing
 Food processing
 Wood processing

Flowrate
 (1000 gpd)

5000
 7
 120
 9

Problem Pollutants

BOD, COD, SS
 BOD, COD, SS
 BOD, SS
 oil, phenols

PLANT LOADING

Aeration Basin

MCRT, days
 MLSS, mg/l
 Detention Time, hours
 Return Flow, %
 D.O. Level, mg/l

Typical (Upset)

20-40
 1000
 20
 40-60
 2.0-4.0

Secondary Clarifiers

Overflow Rate, gal/sd/day
 Detention Time, hours

Typical (Upset)

350
 2.4

PLANT PERFORMANCE

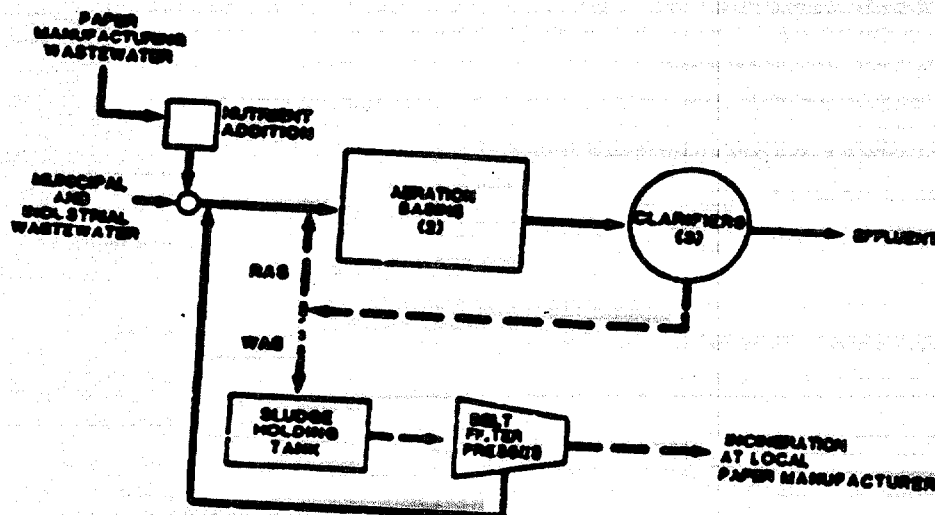
BOD₅, mg/l
 SS, mg/l

Permit Limit

30
 75

Typical (Upset)

20-40
 40-150



CITY OF BALTIMORE, MARYLAND

The City of Baltimore owns and operates two wastewater treatment facilities, Back River and Patapsco, with a combined volumetric flow rate of approximately 250 million gallons per day. The plants serve a combined population of nearly 1.3 million, residing in the City and the Counties of Baltimore, Anne Arundel and Howard. In accordance with the requirements of the General Pretreatment Regulations (40 CFR Part 403) established by the U.S. EPA, the City developed an extensive industrial waste control program to:

- safeguard the public's health;
- protect the wastewater systems and its employees; and
- prevent deterioration of the receiving waters and lands.

The final report outlining the details of the industrial waste program identified 4,700 sources or potential sources of nondomestic wastewater, of which about 220 are EPA-designated categorical industries. A program of this magnitude requires a significant commitment in terms of personnel, equipment, office space, and supplies. Annual operating costs are expected to exceed \$2.5 million by fiscal year 1989.

As part of an initial sampling effort, 35 nonconventional organic and inorganic pollutants were identified in the influent to the two POTWs. Based on these data, the following industrial discharge criteria were recommended or reiterated in the industrial waste control program final report:

<u>Parameter</u>	<u>Limitations</u> <u>(mg/l, except pH)</u>
pH	6.0
FOG	100
CN ⁻	0.2
Cd	0.18
Cr (Total)	5
Cu	1.9
Pb	0.7
Hg	0.01
Ni	2.5
Zn	2.6
Explosivity	10% LEL

The report further specifies the need for continual monitoring of influent and effluent toxicity through the use of Microtox and bioassay methods at both treatment plants.

One of the more interesting aspects of the Baltimore program is the computer coding of the sewer collection system. By knowing the constituents of each industry's discharge, the flow rate and their location in the coded sewer system, a contaminant discovered at either POTW can theoretically be traced back to its potential source or sources. While such a backtracking program is of little use for isolated discharges, it could prove beneficial in locating chronic dischargers of specific compounds.

BACK RIVER WASTEWATER TREATMENT PLANT Baltimore, Maryland

The Back River facility is hydraulically and organically overloaded, resulting in effluent BOD and SS consistently in excess of the 45 mg/l interim limits. The plant is currently undergoing a major renovation to replace the 30 acres of trickling filter rock media with complete-mix activated sludge, along with significant alteration and expansion of most process units. The renovation work is in preparation for new NPDES Permit limits of 10/10 and 2 mg/l (NH₃), which will require the addition of powdered activated carbon as an aid for nitrification. Industrial flows to Back River total approximately 27 mgd, and are dominated by metals and solvents in the discharge.

The primary source of metals in the system is from the 12 metal plating operations identified by the industrial waste survey. The problem with the metals content in the wastewater is that it restricts the ultimate disposal options for the digested and dewatered sludge. When local limits were calculated based on unrestricted distribution of the sludge, the limits were occasionally one-fourth of the achievable levels. Consequently, the City of Baltimore opted for the less stringent 10,000 gpd electroplater standards for the noncategorical industries. A compost facility now under construction is expected to process 150 wet tons of the 450 tons produced each day, beginning in March 1987. The metals content continues to remain a concern for this disposal option.

The benefits of pretreatment for metals removal have been demonstrated at Back River. An incinerator had been discharging 2 tons of fly ash per hour into the collection system, which was high in metal content and was responsible for 70 percent of the cadmium in the POTW influent. Other wastewater containing metals were from steel and automobile manufacturing. In each case, pretreatment facilities have come on-line during the past year, with a measurable drop in influent and sludge concentrations. The situation has improved to the point where the City is reevaluating limits and granting exceptions to some industries on a case-by-case basis.

The second major area of concern at the Back River plant stems from the large, batch discharges of solvents, petroleum hydrocarbons and other toxic organics. A 2:00 am discharge of ethylbenzene, xylene and toluene resulted in the evacuation of the largest pump station and other buildings in town. The problem was traced to a paint and chemicals manufacturer, who has since improved its in-house solvent recovery system. A similar evacuation resulted from a 4,000 gallon discharge of xylene by a waste hauler, which was traced to a specific location in the collection system. Tetrachloroethylene has been discovered and traced to dry cleaning operations. While such discharges have not resulted in process inhibition at the plant, the health and safety issues and potential for explosion are of serious concern to the City.

BACE RIVER WASTEWATER TREATMENT PLANT BALTIMORE, MARYLAND

Design Flow: 100 mgd
Secondary Treatment: Trickling Filter and Activated Sludge

INFLUENT WASTEWATER

	Typical (Gpm)
Ave. Flow, mgd	2:0-2:30
% Industrial	15
BOD ₅ , mg/l	250
SS, mg/l	100

SIGNIFICANT INDUSTRIES

Industry	Flowrate (mgd)	Problem Pollutants
Metals Plating '12	0.15	Metals
Auto Mfg.	1.5	Cr, Cu, Ni, Zn
Plant and Chemical	N/A	Chlor. benzenes, toluene, xylene
Refrigerator	N/A	Cd, Hg
Waste Haulers	N/A	Solvents, petroleum hydrocarbons

PLANT LOADINGS

Primary Clarifiers

Overflow Rate, gal/sq ft/hr
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Gpm)

1,000 (1,000)
1.5
100
100

Aeration Basins

Ave. Flow, mgd
F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Gpm)

50
0.5
6.1
2,000
1.5
33-35
2-3

Secondary Clarifiers (A.S./T.F.)

Overflow Rate, gal/sq ft/hr
Detention Time, hours
SVI, ml/gm

Typical (Gpm)

750/950
2.4/2.1
95

Trickling Filter

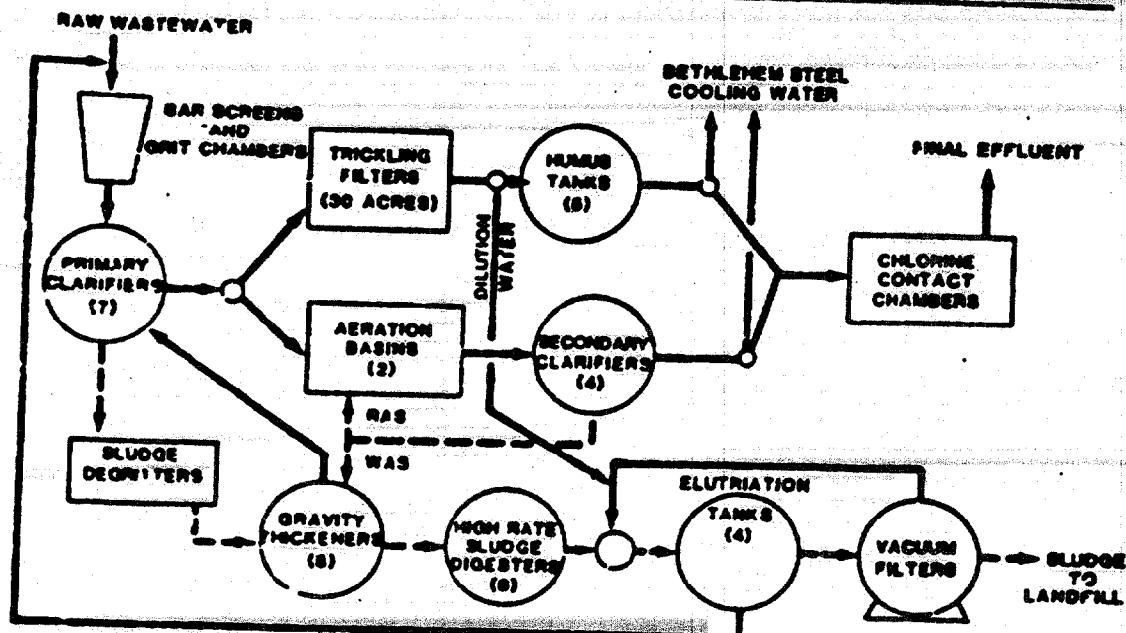
Ave. Flow, mgd
Hydraulic Loadings, gal/sq ft
Organic Loading, lbs BOD/1000 cu ft
Return Flow, %

Typical (Gpm)

150 (170)
120 (130)
20
10

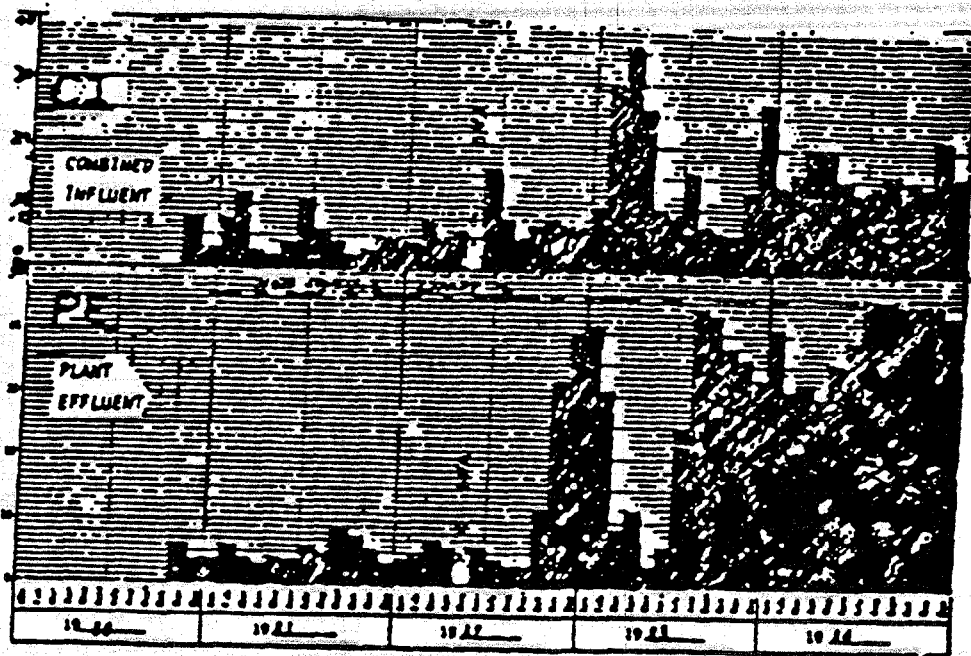
PLANT PERFORMANCE

	Plant Limit	Typical (Gpm)
BOD ₅ , mg/l	45	70-100
SS, mg/l	45	95 (120)



PATAPSCO WASTEWATER TREATMENT PLANT Baltimore, Maryland

A 1981 EPA-sponsored project on bio-monitoring of direct discharges rated the Patapsco plant as having the most toxic effluent of those surveyed. Ironically, the second most toxic discharge came from an agricultural chemicals manufacturer who, in 1981, ceased direct discharging and now sends their pretreated wastewater to Patapsco. The high level of toxicity has resulted in the collection of much bioassay, acute toxicity and respirometer data over the past four years. Despite a high level of measured toxicity in the influent, the plant currently meets its discharge limit for BOD and SS, indicating the ability of activated sludge to acclimatize to consistent levels of many organic compounds. Acute toxicity data using a Beckman Microtox unit have been collected since November 1980. Some of the results of these analyses are shown on Figure C-3. The data are on an inverse scale, with the lowest values indicating highest toxicity and approximately 45 percent corresponding to no toxic effect.



The attached data sheet indicates that Patapasco's noncompliance has resulted from the discharge of excess phosphorus and an effluent pH below 6.5. The phosphorus problem is being dealt with by installing A/O technology in the oxygenation basins as a means of biological phosphorus removal. The low pH is inherent in oxygen activated sludge systems, typically producing an effluent in excess of 250 mg/l of CO₂ and a pH of 6.2. The problem can be corrected with either chemical adjustment or post-aeration of the wastewater.

Although compliance with the NPDES Permit has been achieved for BOD and SS at Patapasco, the plant flow is well below the 70 mgd design capacity. Toxic inhibition is still present despite the improvement since 1983 (see Figure C-3). Evidence of this inhibition is provided by the operating F/M of 0.3, which is significantly less than the design value of 0.5. As a means of further improving the situation, the State of Maryland included the following in the consent order issued to the City in 1984:

- install on-line toxicity monitoring of the plant influent
- develop a toxics emergency response plan
- enlarge the scope of the City sewer ordinance to include specifics on toxicity and flammability for industrial effluents.

PATAPOCO WASTEWATER TREATMENT PLANT BALTIMORE, MARYLAND

Design Flow: 40 mgd
Influent Temperature: Average Design (Flow Cooled)

INFLUENT WASTEWATER

Typical (mgd)
Avg. Flow: 40
BOD₅: 200
SS: 150
TSS: 15

Significant Impurities

Fluoride: 1.3
Total Phosphorus: 1.3
Inhibiting Volatile organic matter
pH: normally 6.5-8.5

PLANT LOADING

Primary Clarifiers

Overflow Rate: gal/sq-ft/day
Detention Time: hours
Effluent BOD₅: mg/l
Effluent SS: mg/l

Typical (mgd)
L: 110
T: 1.1
S: 1.0
D: 60

Aeration Basins

F/M: 0.2 to 0.30 lb BOD₅/lb MLSS/day
MCRT: days
MLSS: mg/l
Detention Time: hours
Return Flow: %
S.O. Level: mg/l

Typical (mgd)
F/M: 0.2
MCRT: 10-15
MLSS: 1,000
Detention Time: 8
Return Flow: 30
S.O. Level: 6-8

Secondary Clarifiers

Overflow Rate: gal/sq-ft/day
Detention Time: hours
SV: mg/l

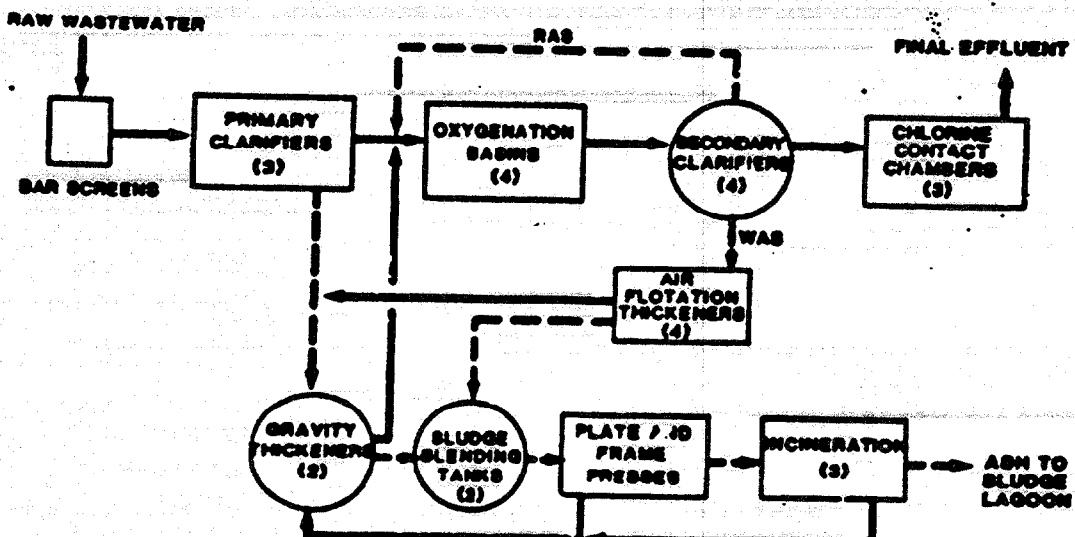
Typical (mgd)
O: 100
T: 0.3
S: 10-15

PLANT PERFORMANCE

BOD₅: mg/l
SS: mg/l
TSS: mg/l
pH
TSS: %

Power Load
kW
hp
TSS: 2.0
L: 1-1.5

Typical (mgd)
BOD₅: 10-20
SS: 20-30
TSS: 1.5
pH: 6-8.5
TSS: 60



CITY OF RAEFORD WASTEWATER TREATMENT PLANT

Raeform, North Carolina

The single most significant discharger to the Raeform Wastewater Treatment Plant is a turkey processor who contributes 30 percent of the flow volume. Until two years ago, the industry was discharging high concentrations of oil and grease (1000 to 1200 mg/l) and large quantities of feathers to the POTW. The problem was so prevalent that flotation thickeners were used in lieu of primary clarifiers in the original plant design during the 1950's. The problem had become unmanageable from a plant operations perspective, hence the municipality required the industry to install flotation on-site, thereby reducing the FOG level to under 100 mg/l.

Raeform's pretreatment program defines a set of surchargeable and prohibitive limits for five parameters:

Parameter	Surchargeable (mg/l)	Prohibitive (mg/l)
BOD	400	800
COD	1000	1600
TSS	350	600
TKN	40	80
FOG	--	100

If an industry's wastewater exceeds the limits defined in the first column during their twice-per-month sampling, the sewer use fees are computed using mass-based unit costs in addition to the flow-based rates. Should an industry discharge wastewater concentrations in excess of the prohibitive values, a notice of violation is issued and the industry is given 30 days to correct the problem prior to the initiation of a five consecutive day sampling program. Consistent noncompliance with these limits can result in a shut-off of services, but such a drastic step has not been necessary for any of the three industries to date.

The turkey processor is routinely surcharged for their discharge, and at the time of the site visit, were in violation of the prohibitive BOD limit. Their most recent sampling analysis indicated the following concentrations (in mg/l):

BOD = 1000
COD = 1400
TSS = 500
TKN = 70

The two other industries in town (a textile mill and a cosmetics manufacturer) each contribute high BOD (600-800) and COD (1200-1400) wastewater to the plant. Since Raeform is only at 2/3 hydraulic capacity, these organic loads do not adversely affect the extended aeration process.

The cosmetics manufacturer has discharged low pH (1.5) wastewater to the plant in the past, which can be toxic to the biological population in the activated

sludge. Effluent BOD has climbed as high as 90 mg/l on occasion. When operations personnel became aware of the problem either by industry notification or increased D.O. in the aeration basins, two procedures have been implemented to mitigate the impact:

- Recycle portions of the aerobic digester to the plant influent, which serves to dilute the low pH wastewater and return healthy organisms to the aeration basins.
- Add lime to the aeration basins to elevate the mixed liquor pH above 6.0.

The other major stumbling block to consistent compliance at Raeford had been the high infiltration/inflow in the collection system. During the summer of 1985, influent flows reached 4 mgd, resulting in a substantial washout of the biological populations. Performing a television survey revealed that one of the two main trunk lines to the plant (an 18" pipeline) had collapsed. By simply closing off the collapsed line (the parallel 24" pipeline was adequate), the I/I flow increment was reduced to 100,000 gpd.

RASFOR WASTEWATER TREATMENT PLANT **RASFOR, NORTH CAROLINA**

Design Flow:
 Secondary Treatment: 3.0 mgd
 Activated Sludge
 (Extended Aeration)

Location:
 Population Served: South-Central North Carolina
 4150

INFLUENT WASTEWATER

	Typical (Upset)
Infl. Flow, mgd	2.9
% Industrial	60
BOD ₅ , mg/l	130-170
SS, mg/l	230-300

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Pollutants
Poultry	450	COD, BOD, TSS, TRN
Toxic	100	CO ² , BOD
Cosmetics	35	9% COD, BOD

PLANT LOADING

Primary Clarifiers
 Overflow Rate, gal/sq ft/day
 Detention Time, hours

Typical (Upset)
 1050
 1.5

Aeration Basins
 F/M, lbs BOD₅/lb MLSS/day
 MCRT, days
 MLSS, mg/l
 Detention Time, hours
 D.O. Level, mg/l

Typical (Upset)
 2.1-2.35
 5-10
 3000
 9-2
 3-5

Secondary Clarifiers

Overflow Rate, gal/sq ft/day
 Detention Time, hours
 SVI, cc/gm

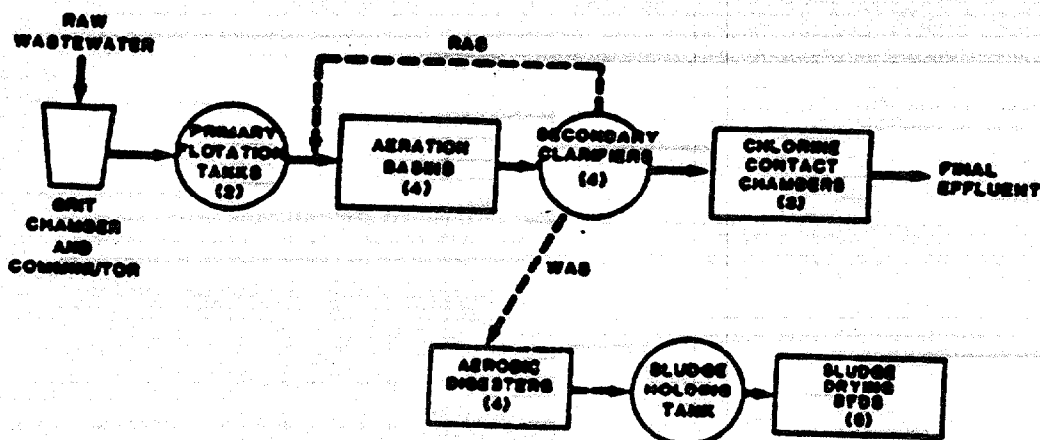
Typical (Upset)
 230
 9
 150-250

PLANT PERFORMANCE

BOD₅, mg/l
 SS, mg/l

Percent Limit
 30
 30

Typical (Upset)
 25 (50)
 25 (50)



NEUSE RIVER WASTEWATER TREATMENT PLANT

Raleigh, North Carolina

In 1976, the 30 mgd Neuse River Wastewater Treatment Plant (NRWTP) went on-line to replace the overloaded 16 mgd Walnut Creek plant. The City of Raleigh has historically been a community that attracted industry. In the early 1960's, influent BODs exceeded 300 mg/l at Walnut Creek, with the effluent ranging from 35 to 55 mg/l. Industries were encouraged to conserve and recycle wastes, resulting in a 250 mg/l BOD by the mid-1960's. The City's first Sewer Use Ordinance was enacted in 1972, with continual modification to comply with changes in the Federal regulations. The net effect is a current influent BOD consistently below 200 mg/l, despite an industrial flow volume representing 25 percent of the plant flow.

The only significant industrial discharge to the Walnut Creek plant was a large electroplater whose occasional plating bath dumps were not prohibited by a sewer use ordinance during the 1950's. Digester upsets (decreased gas production) and high sludge metals content were traced to this particular industry. Since dried sludge was being made available to the community for landscaping purposes at the time, concern for the metals levels prompted adoption of a proposed ordinance which directed the industry to construct a physical-chemical pretreatment facility.

Two other metals-related industries have been responsible for high sludge metals since the construction of the NRWTP. In the current facility, wet sludge is land applied to farmland adjacent to the POTW, hence metal content is critical. In each case (an electroplater and a printed circuit board manufacturer), the industries were discharging levels of Cr, Ni, Zn, Pb and Cu sometimes in excess of 1,000 mg/l, with highly variable effluent pH, and were uncooperative in dealing with the City of Raleigh. Fining the former industry \$1,000, and threatening the latter with same, provided sufficient incentive to install pretreatment.

In the early 1980's a producer of amino acids for pharmaceuticals was attracted to Raleigh and given the false impression they would be able to discharge slug loads totaling 1,000 lbs of NH_3 to the POTW each day. Fortunately, an activated sludge system had been constructed for their facility for BOD reduction, which possessed sufficient capacity to nitrify their wastewater to an ammonia concentration of 50 mg/l. On one occasion, the NH_3 levels became toxic to the pretreatment activated sludge, resulting in a gradual loss of nitrification at the POTW. Continual monitoring of alkalinity and NH_3 allowed the City to preserve their own nitrifier population while at the same time re-seeding the industry's activated sludge with a viable nitrifier population for a speedy recovery. The rapid response prevented the monthly effluent NH_3 levels from exceeding the permit limit, despite high daily concentrations following the incident.

A dairy product manufacturer who cleans the stainless steel tanker trucks on-site had previously discharged these wastes directly to the sewer. Average BODs of 10,000 mg/l, with occasional values in the 30,000 to 40,000 mg/l range were typical. Working with the North Carolina State University, a vacuum recovery

system was developed and a market identified for the collected whey waste. The effluent BOD now averages 2,000 mg/l, still resulting in a high surcharge payment. The City of Raleigh has waived the prohibitive BOD limit of 1,500 mg/l in this case because space limitations on the industry's property prevents them from installing additional pretreatment.

An unusual case at the NRWTP was the discovery of high zinc levels (1,000 mg/l) in the discharge from an office building with no manufacturing component. Through discussions with maintenance personnel, the City of Raleigh discovered that the contaminated discharges corresponded to floor stripping activities in the building. It turns out that a Zn-based floor wax had been used, and stripping an entire office building over the course of a week discharged enough Zn to the POTW to significantly raise the level in their sludge.

The Raleigh plant is currently under construction to increase the hydraulic capacity from 30 to 40 mgd, with an additional expansion to 60 mgd planned for the near future (the schematic shown on the next page is for the 40 mgd facility). The rapid growth of this community will continue to bring with it a variety of challenging new industrial wastewaters with, in some cases, unpredictable impacts on the POTW. The Raleigh case study illustrates the need for continuous survey and monitoring even after the implementation of a successful industrial waste program in any dynamic population center.

NEUSE RIVER WASTEWATER TREATMENT PLANT RALEIGH, NORTH CAROLINA

Design Flow: 40 mgd
Secondary Treatment: Activated Sludge
(Extended Aeration)

Location: Central North Carolina
Population Served: 171,300

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	25
Flow, mgd	25
BOD ₅ , mg/l	155-350
SS, mg/l	175-650

SIGNIFICANT INDUSTRIES

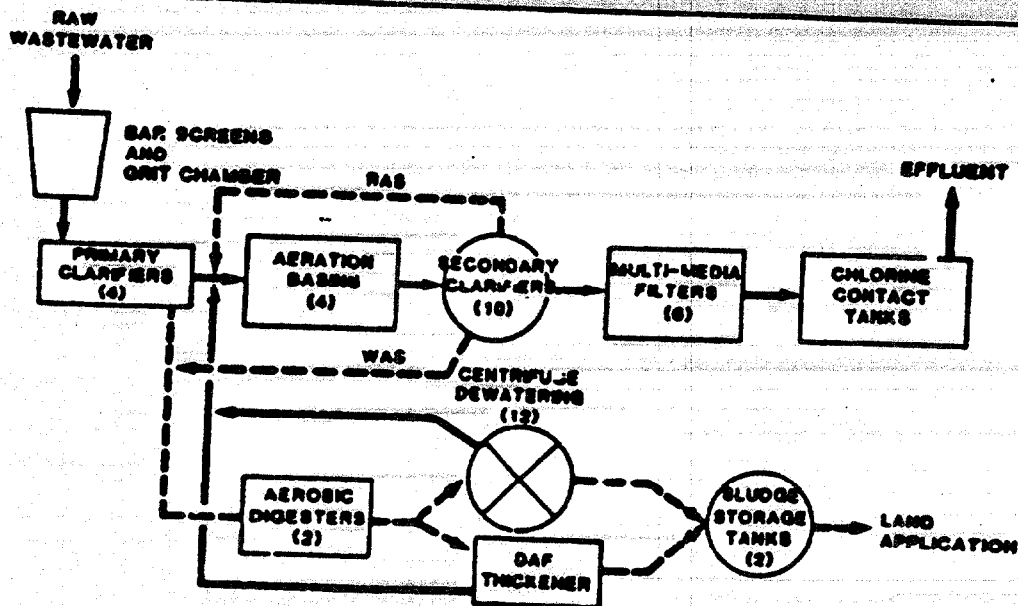
Industry	Flowrate (1000 gpd)	Problem Pollutants
Electroplating, Metal Finishing Pl	50	Cd, Cr, Cu, Ni, Pb, Zn, Ca ⁺⁺ , Fe, pH
Pharmaceutical	400	NH ₃
Dairy	115	BOD
Food	170	BOD

PLANT LOADING

Primary Clarifiers	Typical (Upset)	Aeration Basins	Typical (Upset)
Overflow Rate, gal/sf/day	650	F/M, lbs BOD ₅ /lb MLSS/day	.08-1.0
Detention Time, hours	1.5	MCRT, days	12-20
Secondary Clarifiers	Typical (Upset)	MLSS, mg/l	3500
Overflow Rate, gal/sf/day	600	Detention Time, hours	15
Detention Time, hours	1.2	Return Flow, %	90
SVI, ml/g	150-200	D.O. Level, mg/l	2
Effluent BOD ₅ , mg/l	5	Multi-Media Filters	Typical (Upset)
Effluent SS, mg/l	15	Hydraulic loading, gpm/sf	2.5
Effluent NH ₃ , mg/l	1		

PLANT PERFORMANCE

	Permit Limit		Typical (Upset)
	Summer	Winter	
BOD ₅ , mg/l	5	12	1:10
SS, mg/l	30	30	4
NH ₃ , mg/l	1	6	1.5 (8)



HORSE CREEK POLLUTION CONTROL FACILITY

North Augusta, South Carolina

The Horse Creek Pollution Control Facility (HCPCF) is a regional plant, operated by the Aiken County Public Service Authority (ACPSA), treating a predominantly industrial wastewater. Ninety five percent of the industrial wasteload is contributed by several large textile mills and is characterized by high COD, BOD, alkalinity and pH. Combined domestic/industrial influent wastewater pH fluctuations of up to 2.5 units per day and alkalinity fluctuations of up to 600 mg/l per day caused inhibition of the biomass, poorly settling sludge and caused effluent suspended solids permit violations. Since implementing a pretreatment program and issuing industrial wastewater discharge permits, the treatability of the industrial waste has improved, the result being that HCPCF has been free of NPDES permit violations for over eight months.

Local textile processes include grading operations, finishing processes utilizing dyes, and specialized textile chemical manufacturing. The textile wastewater is highly caustic with alkalinity as high as 2400 mg/l, and pH exceeding 12.5. Prior to pretreatment the combined industrial/domestic influent to the HCPCF had the following characteristics:

pH	>11
BOD	360 mg/l
COD	910 mg/l
Alkalinity	1100 mg/l
TSS	210 mg/l

Other distinguishing characteristics of the influent wastewater included the extremely light nature of the suspended solids and a dark blue/black color, typical of textile wastewater from washing and dying operations.

Prior to the summer of 1985, the textile industries employed a limited type of pretreatment and flow equalization. This limited pretreatment and flow equalization resulted in the previously mentioned plant influent pH fluctuations of 2 to 2.5 units and alkalinity fluctuations of up to 600 mg/l in a given day. These fluctuations caused some inhibition of the biomass, but because the hydraulic detention time in the aeration basins was in excess of 3.5 days, effluent BOD was within the permit limit of 33 mg/l. These pH and alkalinity fluctuations had their most detrimental effect on biomass settling characteristics and solids carryover in the secondary clarifier often resulted, lasting for 24-36 hours. During these episodes, filamentous organisms were occasionally observed in the biomass. The solids carryover problem worsened in the winter months when wastewater temperatures were lower, but chlorination of the return activated sludge, the influent to the secondary clarifier and the contents of the aeration basin was somewhat successful at improving settleability. Despite this, the HCPCF still experienced effluent suspended solids violations in 15 of the 19 months prior to September, 1985.

The State of South Carolina mandated that the ACPSA implement and enforce a pretreatment program in the spring of 1984. The ACPSA responded by

developing such a program and issuing draft industrial wastewater discharge permits. Final State approval came in May, 1985. As presently written, the industrial wastewater discharge permits are not restrictive, allowing BOD, COD and alkalinity levels as high as 600 mg/l, 1300 mg/l and 1500 mg/l, respectively. However, the permits have caused the textile industries to make small, but meaningful alterations to their wastewater discharge practices, resulting in average plant influent pH levels dropping from 11-12 to 10 and alkalinity from 1100 mg/l to 700 mg/l. More importantly, maximum daily influent pH fluctuations have been reduced to 0.5 units or less. Figure C-4 shows the magnitude of pH fluctuations both before and after the implementation of pretreatment. Simple modifications at textile facilities to process operations and waste pumping schedules were typical of the changes that were necessary to realize the described results. Because of the more stable wastewater discharge, the HCPCF has realized more consistent plant operation and has not violated its NPDES permit in over eight months.

Some of the textile dischargers do not currently meet the pH and alkalinity limits of their industrial wastewater discharge permits and are under a compliance schedule to do so. The facilities are installing pretreatment works for caustic recovery that should significantly lower pH and alkalinity levels. The HCPCF is also presently studying the addition of floating mixing units to augment the turbine surface aerators in the aeration basins. To date, evidence indicates that a more consistent secondary clarifier solids feed is achieved which improves the quality of the secondary effluent.

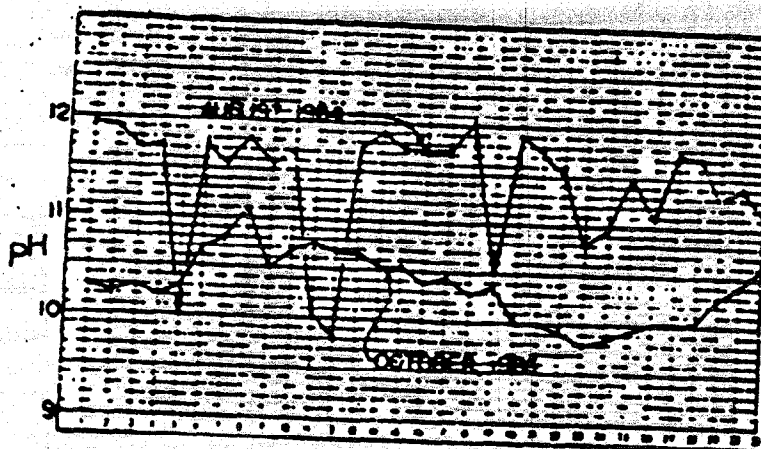


FIGURE C-4
HCPCF INFLUENT pH

HORSE CREEK POLLUTION CONTROL FACILITY Albemarle County, South Carolina

Design Flow:
Industrial Wastewater

20 mgd
Extended-Aeration
Activated Sludge

Location:

Population Served:

West-central South Carolina
70,000

EFFLUENT WASTEWATER

	Typical (Upset)
Flow, MGD	1.4
BOD ₅ , mg/l	10
SS, mg/l	10
Ca ⁺⁺ , mg/l	20
Magnesium, mg/l	100-150
pH	8-11 12.4

SIGNIFICANT INDUSTRIES

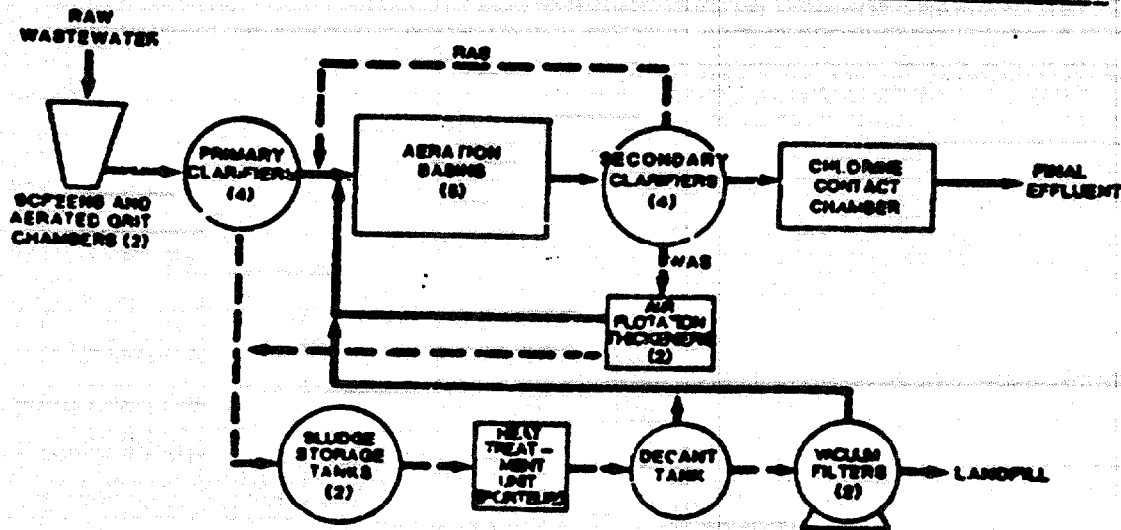
Industry	Flowrate (1000 gpd)	Problem Pollutants
Acetic Acetic chemicals	1.4 M 1.2	Ca ⁺⁺ , Alkalinity, pH FeO, pH

PLANT LOADING

Primary Clarifiers	Typical (Upset)	Aeration Basins	Typical (Upset)
Overflow Rate, gal/sq ft/day	130	F/M, lbs BOD ₅ /lb MLSS/day	0.35-0.10
Detention Time, hours	1.4	MRT, days	50-60
		MLSS, mg/l	3000-4500
Secondary Clarifiers	Typical (Upset)	Detention Time, hours	2
Overflow Rate, gal/sq ft/day	135	Return Flow, %	40-45
Detention Time, hours	2.1	D.O. Level, mg/l	1.3-4

PLANT PERFORMANCE

	Perish Link	Typical (Upset)
BOD ₅ , mg/l	11	11
SS, mg/l	17	40-45
Ca ⁺⁺ , mg/l	1	17
pH	1	1-11



NORTH SHORE SANITARY DISTRICT GURNEE PLANT

Gurnee, Illinois

The Gurnee Plant of the North Shore Sanitary District (NSSDGP) receives an average daily wastewater flow of 12.4 mgd from a variety of sources. Those sources include a major naval installation, domestic sewage discharges, secondary effluent from the District's North Chicago Sewage Treatment Plant, and other industries which contribute 17 percent of the total flow.

Since startup in 1976, the NSSDGP has experienced periodic failures at achieving nitrification in the two-stage activated sludge system. The failures to achieve nitrification to the ammonia levels of the District's NPDES effluent limits have also, at times, been accompanied by general process upsets which have resulted in effluent SS and BOD₅ violations. One of the major industrial contributors to the Gurnee Plant, a pharmaceutical manufacturer discharging an average flow of 750,000 gpd, has similarly experienced upsets of its own activated sludge pretreatment system which have resulted in violations of the District's local sewer use ordinance. It was initially believed that the observed interferences at the NSSDGP were the result of the discharge of filamentous organisms and other solids by the manufacturer. The initiation of in-plant solids control methods (which significantly lessened the quantity of solids entering the industrial wastewater pretreatment system) and pretreatment system upgrades did not, however, eliminate interferences at the NSSDGP.

In 1980, District personnel began to suspect that the presence of a nitrification inhibiting antibiotic, erythromycin, in the pharmaceutical wastewater was the main cause of the process upsets at the NSSDGP. By 1983, test and control bench-scale activated sludge reactors were placed in operation and the effects of the pharmaceutical wastewater and erythromycin on the NSSDGP were investigated. A bioassay test for the presence of erythromycin and other nitrification inhibitors was also developed, along with a Direct Insertion Probe/Mass Spectrometric technique for confirmation. The results of the bench-scale testing indicated that the presence of soluble and/or solid constituents of the pretreated pharmaceutical wastewater inhibited nitrification and, at high levels, could completely suppress nitrification. Additionally, it was found that although erythromycin inhibited nitrification, acclimation to low concentrations of erythromycin could occur in the absence of extreme concentration fluctuations.

During January of 1984, an observed average industrial pretreatment effluent erythromycin concentration of 53 mg/l with mass loading fluctuations of greater than two orders of magnitude completely inhibited nitrification in the Gurnee Plant. The resulting BOD₅ and SS concentrations were as high as 26 mg/l and 57 mg/l, respectively. Lower concentrations of erythromycin in the absence of such strong concentration fluctuations did not interfere with the performance of the Gurnee Plant during August of 1984, with average effluent BOD₅ and SS concentrations of 11 mg/l and 8 mg/l, respectively, and effluent ammonia concentrations ranging from 0.4 mg/l to 1.5 mg/l as N. Experience at the Gurnee Plant and with the bench-scale test systems has also indicated that a lag period of two to three mean cell residence times is required before the effects

of erythromycin on the activated sludge process become apparent. Erythromycin also was found to disrupt the settling of the first-stage carbonaceous organisms.

Measures undertaken by District personnel to lessen the effect of the pharmaceutical discharge on plant performance have included:

- The addition of inorganic coagulants to aid primary clarifier performance;
- the addition of polymer to the first-stage activated sludge system,
- daily bioassays of industrial wastewaters for the presence of inhibiting substances; and
- the development of an ordinance governing the discharge of erythromycin to the NSSDGP.

Since passage of the ordinance in November, 1985, in which the discharge limits of erythromycin were established, the NSSDGP has substantially been in compliance with its NPDES permit and ammonia levels of 0.25 mg/l to 1 mg/l as N have been consistently achieved.

NORTH BROS. SANITARY DISTRICT GUMBER PLANT GUMBER, ILLINOIS

Design Flow:
Secondary Treatment: 11.5 mgd
Activated Sludge
(Two-Stage, Modified Contact)

Location:
Population Served: Northeastern 23rd
61,000

INFLUENT WASTEWATER

	Typical (Upset)
Acc. Flow, mgd	12.0
% Industrial	37
BOD ₅ , mg/l	160
SS, mg/l	100
NH ₃ , mg/l	15

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Pollutants
Pharmaceutical	450	Antibiotics, SS
Electroplating	100	Cu, CH
Chemical	170	Organics
Nonferrous Metals	90	pH
Military Installation	2,500	

PLANT LOADING

Primary Clarifiers
Overflow Rate, gal/sf/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)
105
2.7
130
130

First Stage Clarifiers
Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)
700
2.5

Second Stage Clarifiers
Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)
445
1.1

First Stage Aeration Basins

F/M, lb BOD₅/lb MLVSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)
2.94
7
3500
6.2
25
2.5

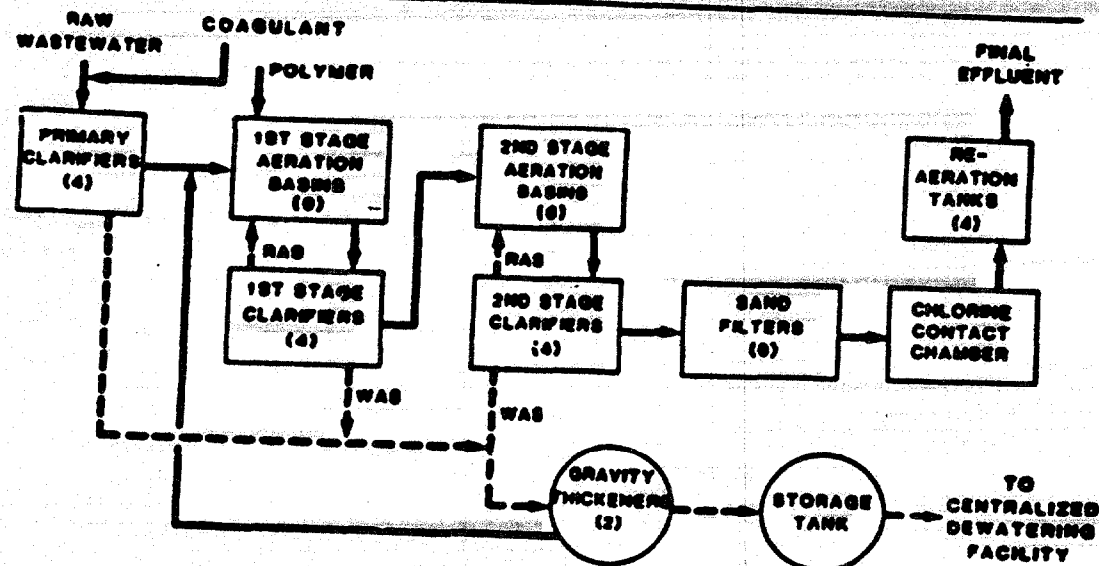
Second Stage Aeration Basins

F/M, lb NH₃-N/lb MLVSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)
0.07
13
3500
5.6
50
2.5

PLANT PERFORMANCE

	Plant Limit	Typical (Upset)
BOD ₅ , mg/l	10	5 (137)
SS, mg/l	12	5 (133)
NH ₃ , mg/l summer	1.5	0.5 (151)



SANITARY DISTRICT OF ROCKFORD SEWAGE TREATMENT PLANT Rockford, Illinois

The Sanitary District of Rockford operates the Rockford Sewage Treatment Plant (SDRSTP) which serves a population of 240,000 and more than 400 industries. Forty-five metal finishers, two dairies, three food processing plants, several large machine tool manufacturers, twenty-five permitted batch waste haulers, a contract waste treatment facility, and several paint manufacturing plants are among the major sources of industrial wastewater. Industrial wastewater contributes 45 percent of the daily average treatment plant flow of 35 mgd. Over the years, the District has experienced sludge disposal problems and isolated excursions of their NPDES permit discharge limits that were related to the industrial discharges to the POTW.

Upon passage of the Resource Conservation and Recovery Act in 1980, the District's thickened sludge was found to be classified as hazardous because of the cadmium content. The local industrial discharge limits, which had been in existence for several years, were therefore tightened for cadmium from 2.0 mg/l down to 0.9 mg/l and sewer use surcharges were applied. The result was that from initial sludge cadmium concentrations of 800 mg/kg in 1980, a level of 50 mg/kg was achieved by 1984. The addition of excess amounts of lime prior to vacuum filtration was practiced as an interim method of rendering the vacuum filter cake nonhazardous (EP-Toxicity method) and therefore acceptable for land filling. This was done to allow contributing industries time to install pretreatment systems and come into compliance with the lower local discharge limits. Presently, the District is investigating the feasibility of land application for ultimate disposal of sludge.

Isolated incidents of batch discharges of concentrated manufacturing process solutions to the POTW have resulted in process upsets and effluent discharge violations. A batch discharge of a nickel plating solution to the POTW in 1981 resulted in a treatment system upset and effluent BOD and SS concentrations of 38 mg/l and 34 mg/l, respectively. Upon notification of the incident by the industry, the POTW personnel attempted to isolate the contaminated incoming wastewater and confine the nickel slug within the primary clarifiers. However, most of the nickel had passed through the primary treatment units by the time of notification and the process recovered after only a few days. Prior to the nickel spill incident the POTW was subject to a shock load of cyanide in 1977. Upon the arrival of an unknown amount of cyanide at the POTW, it was found to be difficult to maintain a chlorine residual after the disinfection of the secondary effluent. Subsequent analyses revealed effluent cyanide concentrations as high as 1.06 mg/l which were in violation of the NPDES permitted limits of 0.2 mg/l CN⁻. Extensive industrial site visits, sampling and interviews were undertaken, but the source of the spill was not verified. The most intensive shock level of cyanide may have occurred in 1970 when the raw wastewater cyanide concentration increased from less than 0.5 mg/l to 34 mg/l in a period of one hour. Although such shock load interferences as experienced by the SDRSTP are isolated events, they have not been uncommon at the SDRSTP. For example, in 1979 there were 36 NPDES permit violations of the concentrations or mass loadings of cyanide, chromium and zinc.

The District's pretreatment program has been characterized by the establishment of effective local limits for the discharge of metals and toxic substances, an extensive industrial monitoring program, the development of spill notification procedures, and cooperation between the District and the local industries. Over the past ten to fifteen years, 34 industrial pretreatment systems have been installed and the metal finishing industry has reduced its discharge by more than one-half to about 1 mgd. The overall result has been a reduction of the number of toxic, noncompatible-pollutant NPDES violations from the historical numbers of occurrences, such as 16 in 1979, to zero in 1984.

ROCKFORD SANITARY DISTRICT SEWAGE TREATMENT PLANT ROCKFORD, ILLINOIS

Design Pl. #: Secondary Treatment

60 mgd
Activated Sludge
(Conventional)

Location: Northern Illinois
Population Served: 145,000

INFLUENT WASTEWATER

	Typical (Days)
Infl. Flow, mgd	55
% Industrial	65
BOD ₅ , mg/l	160
SS, mg/l	245

Industry
Metal Finishing
Metal Plating
Dairy

SIGNIFICANT CONSTITUENTS

Fluoride (1000 gpd)	Potential Pollutants
25	Zn, Cu, Cd, Ni, Cr
50	CN, Ca, Pb
670	BOD ₅ , SS

PLANT LOADING

Primary Clarifiers

	Typical (Days)
Overflow Rate, gal/sq ft/day	141
Detention Time, hours	1.6
Effluent BOD ₅ , mg/l	110
Effluent SS, mg/l	77

Typical (Days)

Aeration Basins

	Typical (Days)
F/M, lbs BOD ₅ /lb MLSS/day	0.2
WRT, days	24
MLSS, mg/l	2500
Detention Time, hours	4.8
Return Flow, %	33
D.O. Level, mg/l	1.6

Typical (Days)

Secondary Clarifiers

	Typical (Days)
Overflow Rate, gal/sq ft/day	400
Detention Time, hours	1.6
SVI, ml/gm	125

Typical (Days)

PLANT PERFORMANCE

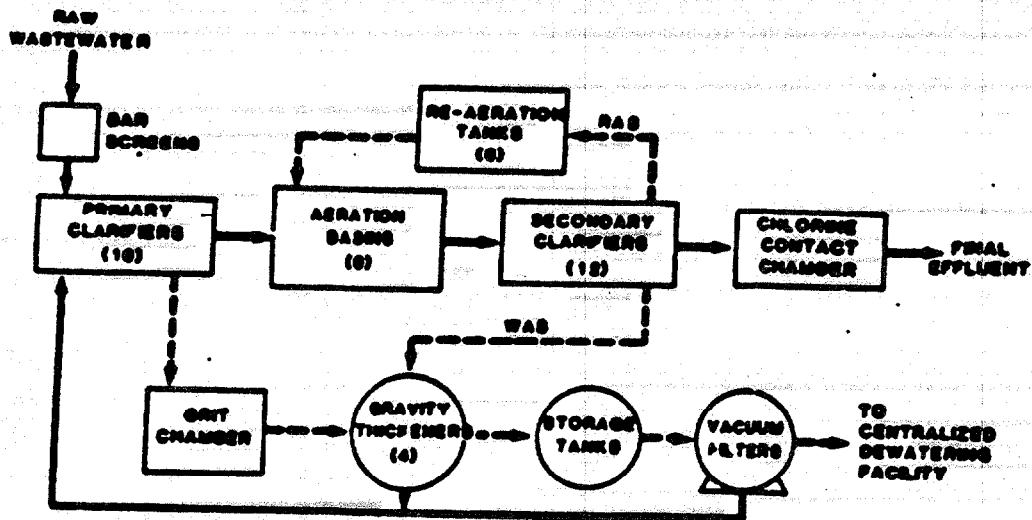
BOD₅, mg/l
SS, mg/l

Permit Limit

20
25

Typical (Days)

20
13



LAKE MILLS WASTEWATER TREATMENT PLANT

Lake Mills, Iowa

The Lake Mills Wastewater Treatment Plant (LMWTP) serves a community of 2,200 persons in North-Central Iowa. Approximately 37 percent of the average flow of 0.33 mgd is industrial in nature and arises from the two major industries within the community. A printed circuit board manufacturer discharges an average flow of 80,000 gpd which contains copper, lead, chromium, nickel and zinc. The other major manufacturing concern discharges 50,000 gpd to the POTW. Presently, there are no problem pollutants associated with this second discharge.

The circuit board manufacturer experienced growth during the past decade which resulted in increased discharges of copper, lead and other metals to the POTW. In 1980, the copper and lead levels in the anaerobically digested sludge were observed to be 4,300 mg/kg and 1,100 mg/kg of dried sludge, respectively. The State then intervened and halted the LMWTP's prior disposal practice of spreading the sludge on agricultural land. Because of a lack of a disposal option, the sludge solids were allowed to accumulate within the single-stage digester of the treatment works with digester supernatant recirculation to the head of the facility. A one-time disposal of 90,000 gal of sludge to a landfill was allowed by the State in 1982 after which solids were again held within the treatment works. Prior to the receipt of a high-rate land application permit in the fall of 1984, the sludge held in the digester contained as much as 16,000 mg/kg of copper.

A program of monitoring the circuit board manufacturer's discharge was initiated in May of 1984 at which time the average copper and lead concentrations being discharged to the POTW were 2 to 4 mg/l and 0.4 to 1.2 mg/l, respectively. The municipality and the manufacturer entered into a pretreatment agreement which resulted in the installation of an ion exchange and precipitation metals removal system. The pretreatment program has resulted in lower metals loading to the POTW. Monthly average copper and lead concentrations of 2.64 mg/l and 0.3 mg/l have been observed in the pretreated industrial discharge. Current municipal regulations require pretreatment discharge limits for metals which are consistent with those of 40 CFR 433 and fines are imposed for each incidence of noncompliance.

As a result of the reduced metals loading to the POTW and of the ability to dispose of digested sludge solids on a regular basis, the metals content of the digested sludge has been reduced to the vicinity of 5100 mg/kg as was observed in December of 1985.

During the periods for which sludge disposal was not practiced on a regular basis, the overall plant performance was found to deteriorate. From average effluent BOD₅ concentrations of 29 mg/l and 24 mg/l in 1982 and 1983, respectively, a yearly average effluent BOD₅ of 40 mg/l was observed for 1984. The effluent BOD₅ for the last quarter of 1985 averaged 22 mg/l. Although the results are not conclusive, it is believed by some that the poor overall plant performance of recent years was the result of high organic and solids loadings (because of digester supernatant recycling) to the trickling filter and possible metal toxicity.

LAKE MILLS WASTEWATER TREATMENT PLANT LAKE MILLS, IOWA

Design Flow: 0.34 (1.1 Hydraulic)
Secondary Treatment: Trickling Filter
(High Rate; Rock Media)

Location: North Iowa
Population Served: 2,500

INFLUENT WASTEWATER

Typical (Upset)

Avg. Flow, mgd 7.15
% Saturated 17
BOD₅, mg/l 100
SS, mg/l 50

SIGNIFICANT INDUSTRIES

Industry: Plastics
Flowrate (1000 gpd): 60
Problem Pollutants: None

PLANT LOADING

Primary Clarifiers
Overflow Rate, gal/sq ft day
Detention Time, hours

Typical (Upset)
400
1.7

Trickling Filter

Organic Loading, lb BOD₅/1000 cu ft/day
Recirculation, %
Covered: Rock Media

Typical (Upset)
47
123

Secondary Clarifiers

Overflow Rate, gal/sq ft day
Detention Time, hours

Typical (Upset)
500
2.1

Polishing Pond

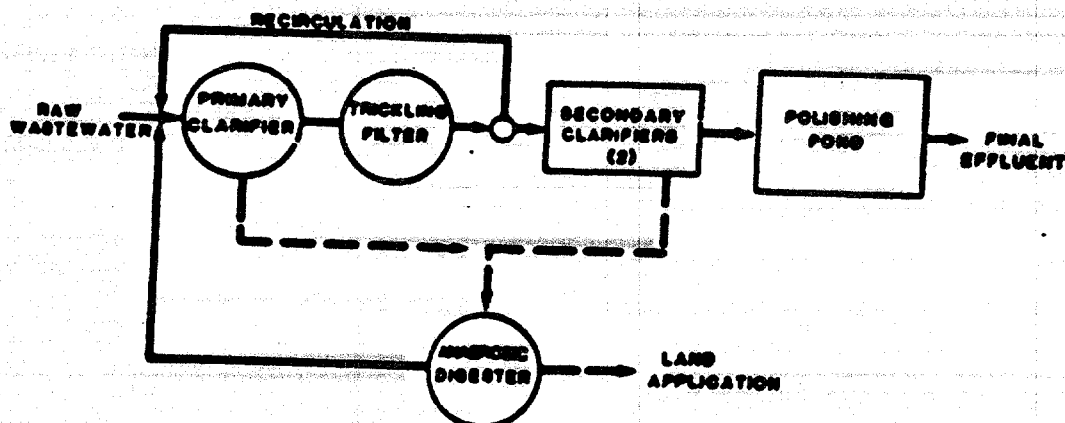
Detention Time, days
Effluent BOD₅, mg/l
Effluent BOD₅, mg/l

Typical (Upset)
54
22 (40)
18 (40)

PLANT PERFORMANCE

Param. Limit Typical (Upset)

BOD₅, mg/l 17 22 (40)
SS, mg/l 10 18 (40)
NH₃, mg/l (Summer) 10 1 (40)



MARSHALLTOWN WATER POLLUTION CONTROL PLANT

Marshalltown, Iowa

The Marshalltown Water Pollution Control Plant (MWPCP) experienced brief periods of effluent BOD limitation violations prior to 1982. The violations were the combined result of high hydraulic loadings to the plant because of infiltration and inflow and excessive BOD₅ loadings which exceeded the capacity of the treatment facilities. Whereas the MWPCP was designed for average daily and peak hydraulic flows of 5.5 and 8.0 mgd, respectively, extreme wet weather flows as great as 20 mgd were experienced. Flows in excess of 8 mgd were found to result in an excessive loss of microorganisms from the activated sludge system and it was necessary to provide only primary treatment for the total flow and bypass secondary treatment for the excess wastewater flows. At the same time that high hydraulic loadings were experienced, BOD₅ loads averaging 14,000 lb BOD₅/day were contributed by a meat packing facility. The average BOD₅ of the industrial loadings represented 65 percent of the average wastewater strength and maximum industrial contributions of 33,000 lb BOD₅/day were observed. Additionally, excessive discharges of grease (up to 15,000 lb/day) had also occurred. Prior to 1982, the industrial wastewater in question was not receiving pretreatment. The effluent limitation violations arose during periods of high hydraulic and high organic loadings at which times plant effluent (secondary effluent plus bypassed primary effluent) BOD₅ concentrations of up to 170 mg/l occurred.

A significant upgrade of the MWPCP was completed in 1982. Included in the upgrade were additional treatment units for increased hydraulic capacity, the installation of a jet aeration system which substantially increased the organic loading capacity, and new sludge handling facilities. The typical data presented in the following table characterize the MWPCP as it now exists. The reported upset parameter values represent the process conditions prior to the 1982 plant upgrade and during periods of high hydraulic and organic loadings.

In conjunction with expansion of the capacity of the MWPCP, the meat packing industrial concern instituted a waste minimization/pretreatment program, upon State intervention, which has reduced the average organic load of the industrial wastewater to 8000 lb BOD₅/day with a solids loading of 4000 lb/day. Livestock holding pen runoff is now subject to primary sedimentation. A blood collection and drying system was installed. The remaining wastewaters are strained and subjected to dissolved air flotation for grease removal. Although other wastewater pretreatment alternatives were proposed, the selected system was economically advantageous because of the potential for protein and grease recovery.

A total of 37 industries were identified in a city-wide industrial survey. Of the 37 industries, 20 were classified as sources of industrial wastewater and of these, six are monitored regularly. One categorical electroplater is subject to a compliance schedule. The total industrial wastewater flow averages 1.2 mgd. The present industrial pretreatment program consists of sampling and analysis of the industrial discharges, as conducted by MWPCP personnel, and close cooperation between the municipality and the various industries. There have been

no recent events of noncompliance on behalf of the MWPCP because of industrial waste discharges. There have, however, been several instances of potential interferences to MWPCP operation because of industrial waste discharges. For example, elevated but noninterfering concentrations of lead in the treatment plant influent were traced to the batch dumping of a lead-acetate solution used in the manufacture of latex paint. The lead was voluntarily eliminated from the wastewater initially by reuse and more recently by process substitution.

MARSHALLTOWN WATER POLLUTION CONTROL PLANT MARSHALLTOWN, IOWA

Design Flow: 7.5 mgd (11.0 hydraulic)
Secondary Treatment: Activated Sludge (Conventional)
Largest Population Served: 27,000
Control Area

INFLUENT WASTEWATER

Typical (Upset)
Avg. Flow, mgd 4.1 (5.0)
% Industrial 10
BOD₅, mg/l 450 (500)
SS, mg/l 170

Industry
Meat Packing
Electroplating
Metal Finishing
Paint Manufacturing

SIGNIFICANT INDUSTRIES

Flowrate (1000 gpd)	Problem Pollutants
800	BOD ₅ , grease
10	Cu, Ni, Cr
18	Zn
1	Hg

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)

1000 (1450)
1.25 (0.84)
120 (100)
135

Aeration Basins

r/M, lbs BOD₅/lbs MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
D.O. Level, mg/l

Typical (Upset)

0.4
13
2900
7 (4.0)
1.0

Secondary Clarifiers

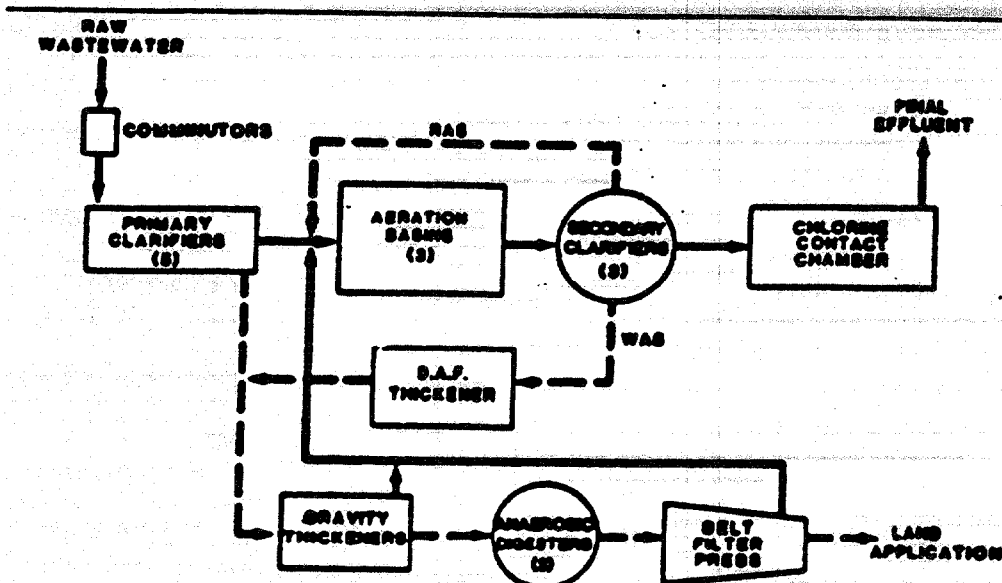
Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)

450 (400)
2.2 (1.9)

PLANT PERFORMANCE

Parameter	Typical (Upset)
BOD ₅ , mg/l	25 (170)
SS, mg/l	25



SIOUX CITY WASTE TREATMENT PLANT (SCWTP)

Sioux City, Iowa

The Sioux City Waste Treatment Plant (SCWTP) treats a combined industrial and municipal wastewater average flow of 13.5 mgd and discharges to the Missouri River. More than 140 industries were identified by an industrial survey as potential sources of wastewater. Of these, four are categorical metal finishing or electroplating industries and, as of recently, eleven industries contributed significantly to the suspended solids, BOD and oil and grease discharged to the SCWTP. Although the total volumetric load of the industrial wastewater is typically less than 10 percent of the total flow, the industrial organic loads to the plant account for greater than 50 percent of the observed loads.

The SCWTP has experienced two separate instances in which industrial discharges have interfered with normal plant operations. Isolated slug loads of zinc were experienced by the SCWTP in March and again in April of 1984. Levels as high as 16 mg/l Zn were observed in the treatment plant influent and both slug-load incidences resulted in an upset of the activated sludge process and violations of the NPDES discharge limits. Effluent BOD₅ concentrations exceeded 60 mg/l and effluent suspended solids concentrations in excess of 200 mg/l were observed. The investigation of the first slug load of zinc was somewhat hampered by the lack of in-house capabilities for metals analysis and the first indication of a contamination problem was the process upset itself. Upon confirmation of the nature of the interference, a temporary system for the continuous addition of lime to the primary clarifiers, which would result in the precipitation of subsequent slug loads of zinc, was installed and operated until such time that frequent and periodic monitoring and analysis of the influent for metals could be performed at the SCWTP.

The source of the metal discharge was identified from the City's industrial use survey and from samples of wastewater and solids collected at specific locations in the wastewater collection system. In addition to the process upsets, sludge held in storage lagoons at the facilities became contaminated with zinc and plans to dispose of several years accumulation of sludge by spreading on agricultural land were modified upon receipt of special permitting from the State.

In 1985, a pharmaceutical extractor came on line discharging batches of high strength waste without pretreatment. The strength of the waste ranged from 10,000 to 100,000 mg BOD₅/l and the waste contained high levels of salt and sulfite. The average BOD₅ of the waste was 35,000 mg/l and the batch dumps represented 45 percent of the total organic load to the SCWTP. The activated sludge process was severely overloaded and intermittent depressions of the D.O. level occurred. It was possible to operate the activated sludge process to accommodate the severe organic loads, but the process would again be upset during the weekends when the pharmaceutical extractor was not discharging waste and the organic loads were reduced. Throughout 1985, the SCWTP experienced severe violations of their NPDES BOD₅ and suspended solids discharge limits. Frequent violations of the pharmaceutical extractor's discharge permit occurred with respect to the organic strength and daily mass loading of the waste. The industrial user was placed on a compliance schedule

and continued violations of the discharge permit necessitated actions that would result in flow equalization and reductions in the levels of methyl mercaptan, sulfite and sulfide. Presently, all batch waste dumps are transported by bulk to the SCWTP where they are metered, by SCWTP personnel, into the plant influent under controlled conditions.

The upset conditions presented in the following table represent conditions related to the discharge of the pharmaceutical wastewater. The reported upset conditions represent averages for several months of 1983 whereas the typical conditions were based on data for 1984 which spanned nine months and included those months in which the slug loads of zinc were experienced.

BOYZ CITY WASTE TREATMENT PLANT BOYZ CITY, IOWA

Design Flow:
Secondary Treatment: 20 mgd
Aerated Sludge
(Continuous)

Location:
Population Served: Harbourside Area
131,000

INFLUENT WASTEWATER

	Typical (Upset)
Avg. Flow, mgd	22.6
% Industrial	0
BOD ₅ , mg/l	180 (12)
SS, mg/l	110 (350)

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Pollutants
Meat Processing Pharmaceutical Metal Finishing	1,000 0 20	BOD ₅ , oil and grease, SS BOD ₅ , methyl isocyanide, sulfide Zn, Cr, Ni

PLANT LOADING

Primary Clarifiers
Overflow Rate, gal/sd/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)
177
2.9
220 (770)
240 (230)

Aeration Basins

F₀ (No BOD₅ The MLSS/day)
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)
0.2 (0.3)
10
2500
15
60
2.5

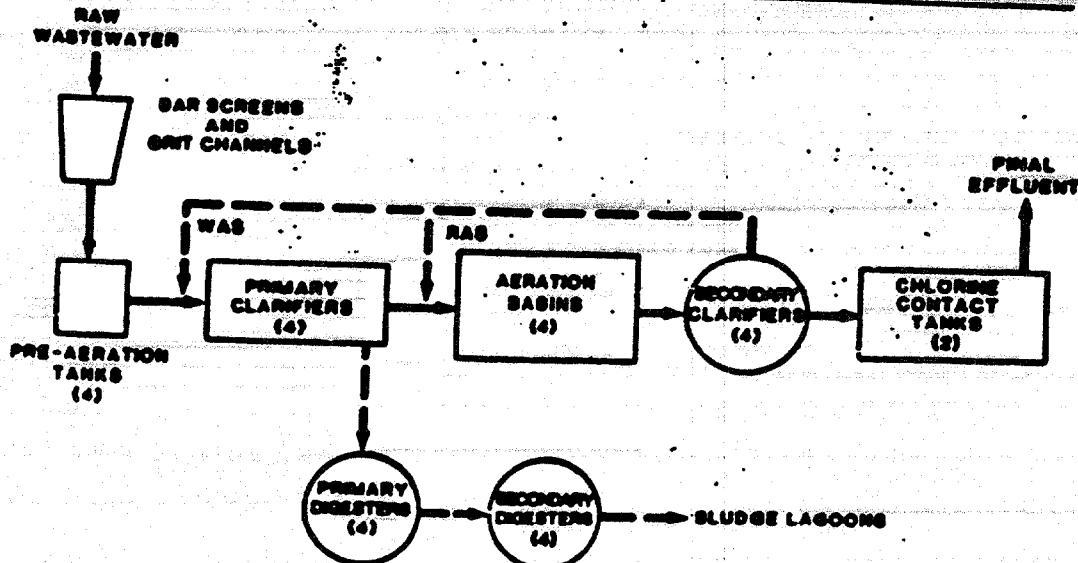
Secondary Clarifiers

Overflow Rate, gal/sd/day
Detention Time, hours
SVI, ml/gm

Typical (Upset)
0.2
1
150

PLANT PERFORMANCE

	Permit Limit	Typical (Upset)
BOD ₅ , mg/l	30	24 (27)
SS, mg/l	30	23 (40)



NEWARK WASTEWATER TREATMENT PLANT (NWTP)

Newark, Ohio

The NWTP had been in substantial non-compliance of their 1981 NPDES Permit from the beginning of 1983 until the middle of 1984. This consistent violation had resulted primarily from increased waste loads on the POTW from industrial sources. Between 1979 and 1984, the percentage of industrial wastewater increased from 12 to 22 percent by volume, with influent BOD increasing from 220 to 330 mg/l, while suspended solids increased from 200 to 350 mg/l. To complicate the non-compliance problem, four separate ammonia discharge episodes occurred from August to October, 1983 which resulted in the killing of 80,000 fish in the Licking River. The fish kill precipitated the submission of Verified Complaints to the Ohio EPA on August 6, 1984 by the Black Hand Gorge Preservation Association, against the City of Newark and the NWTP. Following an investigation, the Ohio EPA issued Director's Final Findings and Orders, specifying a compliance schedule and interim discharge limits until a planned facility upgrade is completed by July 1988.

There are two significant industrial contributors to the NWTP who were also issued Director's Final Findings and Orders in May, 1985. A fiberglass insulation manufacturer had been discharging high concentrations of phenol (2-5 mg/l) and NH_3 (up to 500 mg/l), with occasional spills of formaldehyde into the collection system. The activated sludge bacteria were acclimated to the phenol in the wastewater, but were susceptible to shock loadings of the NH_3 and formaldehyde. Fortunately, the industry was responsive to the problems of the NWTP, and instituted a corrective program to:

- conserve and recycle plant flows, which have reduced their discharge by 60 percent (from 1.22 to 0.45 mgd) over the past two years;
- construct an aerated equalization basin to air-strip phenol and distribute diurnal fluctuations; and
- construct a pretreatment facility for their landfill leachate.

The POTW is still subject to occasionally high NH_3 loads from the industry, which is currently the only identifiable cause of interference problems in the plant. The municipality and industry continue to work cooperatively to resolve this problem through the implementation of a spill prevention and control program. Additionally, the renovated POTW will use some of the existing clarifier tankage for off-line storage in the event of future spill episodes.

A second major industry is a dairy which came on-line in 1976. Initially, the dairy stored their whey waste in a silo and typically bled it into the sewer system. The discharge was high in both BOD and suspended solids (2,000 mg/l), and would occasionally be batch discharged to the POTW, resulting in a shock loading to the activated sludge. The industry has since installed a reverse osmosis treatment system for the whey waste which has reduced the solids and organic loading to the plant.

The only categorical industry that currently discharges to NWTP is an electroplater who constructed a metals removal system in conformance with federal pretreatment regulations. In the past, dewatered sludge had been applied to corn fields adjacent to the plant property. However, when heavy metals were detected in seven of ten monitoring wells, Newark began hauling liquid sludge off-site. The planned facility upgrade will include installation of belt filter presses, so that the existing sludge (with acceptable levels of heavy metals) can once again be dewatered and more economically hauled off-site to farm land.

The replacement of coarse bubble aerators with fine bubble equipment in mid-1984 significantly improved BOD removals and the NWTP compliance record. Nitrification, which did not occur previously, now takes place in the last two aeration basins. The only incident of non-compliance with the interim permit in 1985 resulted from an NH_3 discharge from the fiberglass manufacturer. In this case, even though the average monthly BOD measured 29 mg/l, the carbonaceous component was less than 10 mg/l. The final permit will have a more stringent NH_3 requirement and will also designate CBOD as a permitted parameter.

NEVARE WASTEWATER TREATMENT PLANT NEVARE, OHIO

Design Flow:
Secondary Treatment:

2.0 (1.5) MGD
Activated Sludge
(Conventional)

Location:
Population Served:

Central Ohio
41,000

INFLUENT WASTEWATER

Ave. Flow, mgd
% Industrial
BOD₅, mg/l
SS, mg/l
NH₃, mg/l

Typical (Upset)
1.5
15
300 600
300 500
75 100

Industry
Fiberglass
Dyers
Electroplater

Flowrate
(1000 gpd)
650
323
97

Potential Pollutants

Formal, NH₃, Formaldehyde
BOD, Phosphorus, SS
Cr, Cd, Pb, Ni, Zn, Cyanide

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sq ft day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (Upset)
100
1.5
150 200
107 210

Aeration Basins

F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)
0.25 - 0.4
5-6
2,000
4-5
50
2.0

Secondary Clarifiers

Overflow Rate, gal/sq ft day
Detention Time, hours
SVI, ml/gm

Typical (Upset)
100
3.7
150 200

PLANT PERFORMANCE

BOD₅, mg/l
SS, mg/l
NH₃, mg/l Summer

Permit Limits
20
40
25

Typical (Upset)
15 100
15 190
15 130

RAW
WASTEWATER

BAR
SCREENS

AERATED
GRIT
CHAMBER

PRIMARY
CLARIFIERS
(7)

AERATION
BASINS
(6)

SECONDARY
CLARIFIERS
(6)

CHLORINE
CONTACT
CHAMBER

FINAL
EFFLUENT

ANAEROBIC
DIGESTERS
(3)

LIQUID
SLUDGE
HAULING

91st AVENUE WASTEWATER TREATMENT PLANT Phoenix, Arizona

The 91st Avenue Wastewater Treatment Plant (NAWTP) provides secondary treatment for a major portion of the wastewater flow from the greater Phoenix area. The most significant industrial contributors to the NAWTP are electroplaters and metal finishers--their principal pollutants being cadmium, copper, chromium and cyanide. Because of acclimation, the effect of these metals has not been measurably detrimental to the NAWTP's biological system, although occasionally Cu and Cd pass through the plant to the effluent in concentrations violating permit limits of 0.05 mg/l and 0.01 mg/l, respectively. Most of the metals entering the NAWTP partition to the sludge, which prevented land disposal as an option in the past. An industrial pretreatment program, developed over the last four years and approved in July, 1985, has markedly decreased the amount of metals entering the NAWTP and consequently the pass through and sludge disposal problems have been nearly eliminated.

Prior to industrial pretreatment, influent copper and cadmium concentrations at the NAWTP were approximately 0.25-0.32 mg/l and 0.03 mg/l, respectively. Six to eight percent of the influent wastewater was industrial, nearly all of which originated at metal finishing and plating operations. Typical copper discharge concentrations for some circuit board manufacturers were as high as 40-60 mg/l.

Heavy metals removal from the wastestream was generally greater than 75-80 percent; copper and cadmium concentrations in the digested sludge were measured at 2,020 mg/l and 44 mg/l, respectively in 1983. The concentrations precluded disposal of the sludge on agricultural lands. Fortunately for the City of Phoenix, at about the time these metal concentrations were discovered, a precious metals processor became interested in utilizing the sludge and for five years incinerated all the sludge produced by the NAWTP, recovered the metal content and disposed of the ash to a landfill. Despite the high metals partitioning to the sludge, pass through of copper and cadmium in excess of permitted effluent concentrations was not uncommon. In response, an industrial pretreatment program was developed in 1982 to decrease the influent metal concentrations to the NAWTP. Industries were involved by the City in the program development, and the City of Phoenix offered technical knowledge, short of design, to the industries trying to meet the reduced metal discharge limits. Prior to the implementation of a pretreatment program, most industries had no pretreatment other than flow equalization, and many installed pretreatment works in order to meet the new copper and cadmium discharge limits of 4.5 mg/l and 0.1 mg/l, respectively. A pretreatment and metal recovery system at one large circuit board manufacturer cost in excess of \$ 2.5 million.

As a result of the pretreatment program, typical treatment plant influent copper and cadmium concentrations have been cut to 0.15 mg/l and 0.012 mg/l, respectively, and treatment plant Cu and Cd effluent limits are generally not exceeded. With the reduction in influent wastewater metals concentrations a corresponding reduction in the sludge metal concentrations occurred and it was no longer profitable for the precious metal recovery firm to continue processing and disposing of the NAWTP sludge. However, the metal concentrations were

reduced to a level where the sludge was acceptable as a soil conditioner, and as a result another company has begun marketing the dried sludge commercially. Industries are presently self-monitoring their discharge, with the City sampling most industries at least eight times per year as well. The monitoring frequency is increased when an industry is in non-compliance with its permit. Figure C-5 shows the change in influent metals levels at the 91st Avenue Plant between 1952 and 1955.

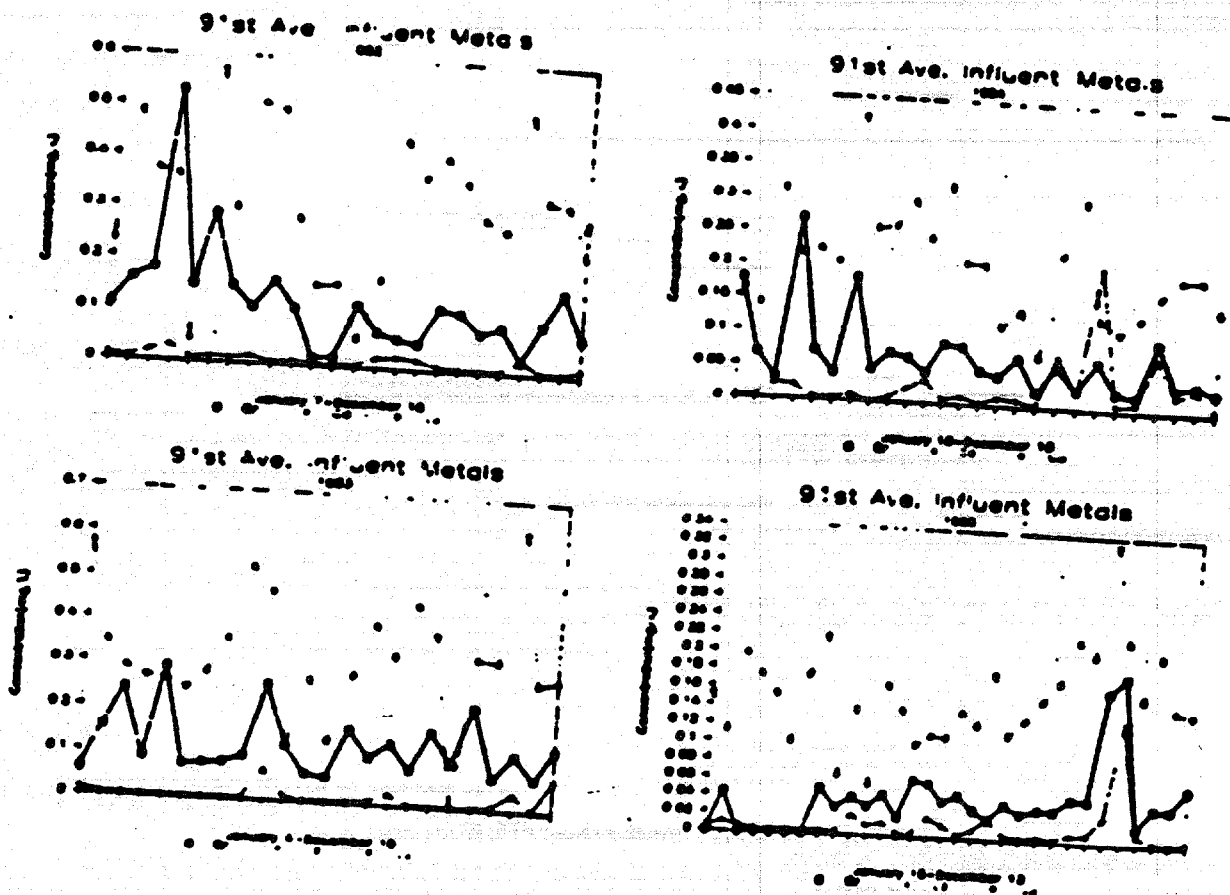


FIGURE C-5
91st AVENUE INFLUENT METALS

9th AVENUE WASTEWATER TREATMENT PLANT PHOENIX, ARIZONA

Design Flow:
Secondary Treatment: 120 mgd
Activated Sludge
(Complete Mix)

Location:
Population Served: South Central Arizona
1,100,000

EFFLUENT WASTEWATER

	Typical
Avg. Flow, mgd	140
% Industrial	0
BOD ₅ , mg/l	20
SS, mg/l	140
pH, mg/l	7.12 - 8.01
Ca, mg/l	115 - 140

SIGNIFICANT INDUSTRIES

Industry	Flowrate (mgd)	Problem Pollutants
Electroplaters and Metal Finishers	19	Cd, Cr, Cu, CN ⁻

PLANT LOADING

Primary Clarifiers

	Typical
Overflow Rate, gal/sq ft	1,750
Detention Time, hours	1.8
Effluent BOD ₅ , mg/l	140
Effluent SS, mg/l	45

Aeration Basins

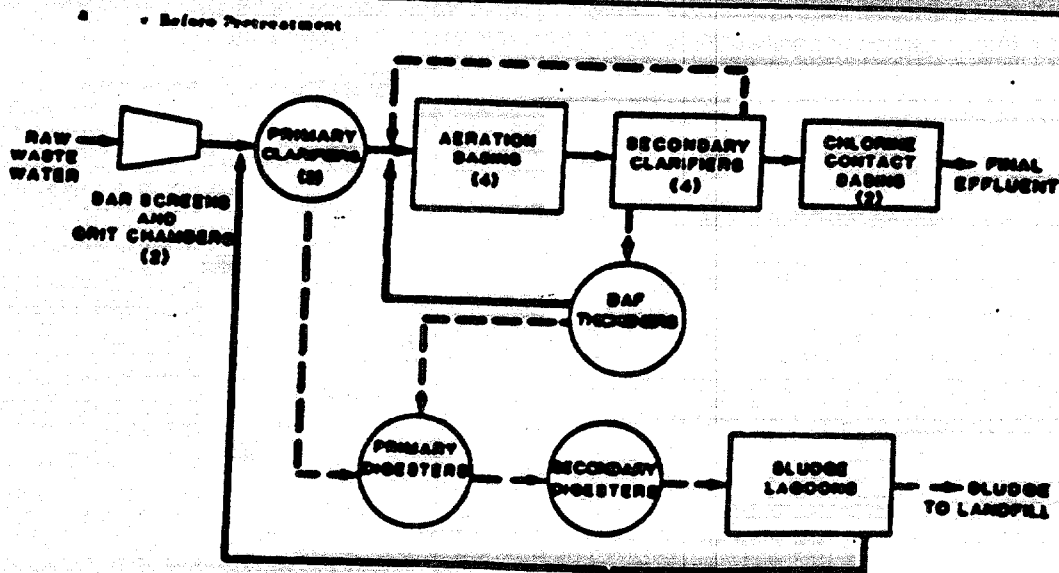
	Typical
MCRT, days	1-2
MLSS, mg/l	100-200
Retention Time, hours	5
Return Flow, %	75
D.O. Level, mg/l	2.0

Secondary Clarifiers

	Typical
Overflow Rate, gal/sq ft	70
Detention Time, hours	2.0

PLANT PERFORMANCE

	Perish Limit	Typical
BOD ₅ , mg/l	30	10
SS, mg/l	30	12
pH, mg/l	0.01	0.005 (0.01)
Ca, mg/l	2.25	0.03 (0.10)



TOLLESON WASTEWATER TREATMENT PLANT

Tolleso, Arizona

The Tolleson Wastewater Treatment Plant (TWTP) is a two stage trickling filter plant that treats a predominantly domestic wastewater from Phoenix, Arizona suburbs. The successful operation of the TWTP is dependent on the one significant industrial contributor to the treatment plant, a meatpacker who processes 1,000 to 1,400 head of beef per day. The treatment plant typically discharges effluent with BOD₅ and SS levels both below 10 mg/l, but has been upset on occasion to the point of effluent permit non-compliance when it receives slug loads of blood and grease from the meatpacker with BOD₅ and SS levels of up to 2,200 mg/l and 1,375 mg/l, respectively. Upset frequency and severity have been reduced in recent years through improved industrial waste monitoring and treatment process monitoring, respectively.

The influent to the TWTP could be typified as medium to high-strength municipal wastewater with average BOD₅ and SS levels being 275 mg/l and 225 mg/l, respectively. Approximately 25 to 30 percent of the organic and solids loading is contributed by the meatpacker on an average basis at levels of 1,100-1,600 mg/l BOD₅ and 700-1,400 mg/l SS, for wastewater flows of 0.8-1.0 mgd. In general, the domestic/industrial waste stream can be treated to well within 30/30 discharge limits, but in the past the meatpacker would upset the treatment process by slug discharging blood or some other high strength organic slaughter by-product. Prior to 1982, these upset conditions would last for several days and result in weekly and monthly effluent suspended solids of 30-40 mg/l, in violation of permit limits.

Treatment upsets have diminished in frequency and intensity since 1982 for two reasons:

- A legal contract with the meatpacker limits flow to 0.8 mgd, BOD₅ to 10,675 lbs per day (1,600 mg/l) and SS to 6,670 lbs per day (1,000 mg/l), and provides for fines or disconnection if these limits are exceeded, and
- Improved treatment plant process monitoring has enabled operators to better detect, and thus act on, a potentially upsetting condition.

The contract with the meat packer attempts to prevent waste blood from being stored for more than about eight hours at a time before discharging to the sewer. Prior practice resulted in blood being held back for up to a week at a time before being discharged all at once.

Primarily through trial and error, the operators of the TWTP have established several operating parameters that help them in detecting upset conditions in the plant. The depth of sludge in the primary clarifiers is monitored closely; a high or rapidly increasing sludge depth is indicative of upset conditions and is caused by the high solids content of the meatpacking waste. The mixed liquor in the solids contact basin following the second trickling filter is monitored closely as well, with levels above 500 mg/l signaling possible problems. Mixed liquor

concentrations of 1,500 mg/l generally result in effluent suspended solids of greater than 30 mg/l. To remedy an upset condition, primary sludge pumping rates are manually increased above their normal levels to reduce solids inventory and prevent escape in the effluent.

As a result of all industrial wastewater interference prevention work, the TWTP has gone from experiencing periodic effluent permit violations to experiencing infrequent upsets, seldom resulting in NPDES Permit violations.

TOLLESON WASTEWATER TREATMENT PLANT TOLLESON, ARIZONA

Design Flow:
Secondary Treatment:

6.1 mgd
2 Stage Trickling Filter
with Solids Contact

Location:
Population Served:

South Central Arizona
64,000

INFLUENT WASTEWATER

	Typical (10year)
Avg. Flow, mgd	6.4
% Industrial	14
BOD ₅ , mg/l	175-340
SS, mg/l	225-280

SIGNIFICANT INDUSTRIES

Industry	Flowrate (1000 gpd)	Problem Pollutants
Meat Packing	1200	BOD, SS

PLANT LOADINGS

Primary Clarifiers
Overflow Rate, gal/sd/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (10year)
600
1.9
100
95

First Stage Trickling Filter
Hydraulic Loading, gal/sd/day
Organic Loading, lbs BOD₅/1000 cu ft/day
Recirculation, %

Typical
1,500
45
100

Intermediate Clarifiers

Overflow Rate, gal/sd/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (10year)
775
2.4
10
10

Second Stage Trickling Filter
Hydraulic Loading, gal/sd/day
Recirculation, %

Typical
500
100

Secondary Clarifiers

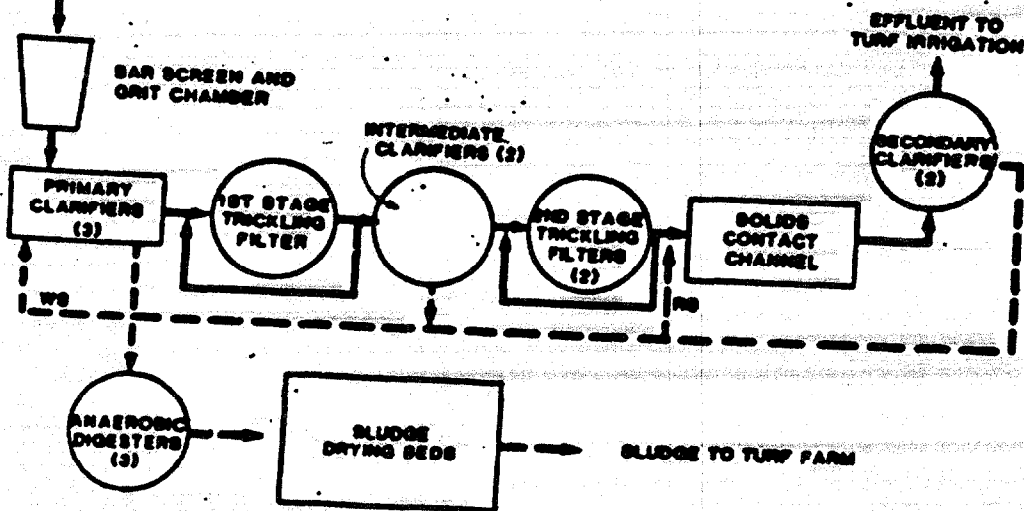
Overflow Rate, gal/sd/day
Detention Time, hours

Typical (10year)
600
7.0

PLANT PERFORMANCE

	Percent Limit	Typical (10year)
BOD ₅ , mg/l	10	9 (25)
SS, mg/l	10	9 (35)

RAW WASTEWATER



VICTOR VALLEY REGIONAL WATER RECLAMATION PLANT (VVRWRP)
Victorville, California

The VVRWRP has, since 1981, experienced periodic activated sludge upsets accompanied by chronic aeration basin and anaerobic digester foaming problems, believed to be caused by solvent-type chemicals. During this same period, COD levels up to three times the permitted effluent limit of 15 mg/l have also been discharged. Initial efforts to discern the cause of the upsets and foaming, and document the source of the pollutants were limited to visual and olfactory investigation of the treatment facilities and sewer interceptors. Recently, more thorough attempts to document the upsets (wastewater sampling and laboratory analyses) have resulted in positive identification of the upsetting pollutants and source, and have established the framework for the correction of the problems.

Start-up of the VVRWRP, treating primarily domestic wastewater, was completed in June, 1981 with the connection of an Air Force Base (AFB) sewer interceptor. The AFB contributes both domestic and industrial wastewater with vehicle and plane washing, jet fueling and paint stripping facilities producing the largest industrial flows. The VVRWRP began experiencing effluent COD permit violations, aeration basin foaming and occasional biological upsets shortly after the connection of the AFB sewer interceptor. The foaming and upset problems continued into 1985 without significant efforts made to document the cause or source of the problems. Chemical addition and variation of the food to microorganism ratio and the mixed liquor suspended solids were unsuccessful at mitigating the foaming problems. Periodically, strong solvent or oil odors were detected at the treatment facility and in the influent wastewater, coinciding with two-fold effluent BOD and COD increases. Attempts to trace the odor of the pollutants to the source generally implicated the AFB, but no further action to substantiate the AFB as the pollutant source was immediately initiated.

Decisive steps were taken to document and correct the problems following a February, 1985 "spill" of pollutants with a strong solvent smell into the treatment plant. Wastewater samples were immediately taken at the plant influent, the AFB interceptor and the sewer above the AFB connection. Laboratory analyses showed significant concentrations of a number of pollutants in both the plant influent and in the AFB wastewater. Other similar events were sampled and analyzed from July through September, 1985. The ranges of concentrations detected for six compounds during the July-September upset sampling are shown below:

<u>Compound</u>	<u>VVRWRP Influent</u> <u>(ug/l)</u>	<u>AFB Effluent</u> <u>(ug/l)</u>
Chloroform	15-23	10-55
Methylene Chloride	11-43	11-1600
Toluene	11-29	43-100
m, p-Xylene	11-19	56-320
Phenol	11-12	11-230
bis (2-Ethylhexyl) phthalate	39-210	17-830

During upset conditions, effluent COD values doubled to approximately 35 mg/l and turbidity levels exceeded 2 NTU, also in violation of effluent limits. Methylene chloride concentrations as high as 68 mg/l were measured in the February analysis of the AFB effluent.

The documented upsets resulted in discussions between VVRWRP and the AFB officials, with the district requesting that base practices causing the discharge of inhibitory levels of contaminants be stopped. The AFB pretreatment currently consists only of poorly operated oil-water separation units.

Despite the VVRWRP-AFB dialog, the treatment plant continues to experience foaming problems and violate effluent COD limits, presumably because of the AFB discharges. A formal "Cease and Desist" order was issued to the AFB in September, 1985. As of this writing, a wastewater sampling and analysis program is being completed by the AFB as the first step of a negotiated agreement to correct the sewer discharge/treatment plant interference problem.

VICTOR VALLEY REGIONAL WATER RECLAMATION PLANT VICTORVILLE, CALIFORNIA

Design Flow:
Secondary Treatment:

4.8 mgd
Activated Sludge
(Modified Step Feed)

Location:

Southeastern California

Population Served:

40,000

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	1.8
% Industrial	15
BOD ₅ , mg/l	250-300
TOD, mg/l	350-400
SS, mg/l	200-400

Industry

Military Base
Cement Mfr.
Restaurants

Flowrate
(1990 gpd)

950

110

-

Problem Pollutants

Methylene chloride; Toluene; m, p-Xylene
cement dust
fats and grease

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)

972

1.71

Aeration Basins

F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)

0.3-0.6

5-10

2000

7.3

50-100

0.5-1.0

Secondary Clarifiers

Overflow Rate, gal/sf/day
Detention Time, hours

Typical (Upset)

933

6.71

Pressure Filters

Filtration Rate, gal/sf/min

Typical

2.54

PLANT PERFORMANCE

BOD₅, mg/l
COD, mg/l
SS, mg/l
Turbidity, NTU

Permit Limit

19

15

10

2

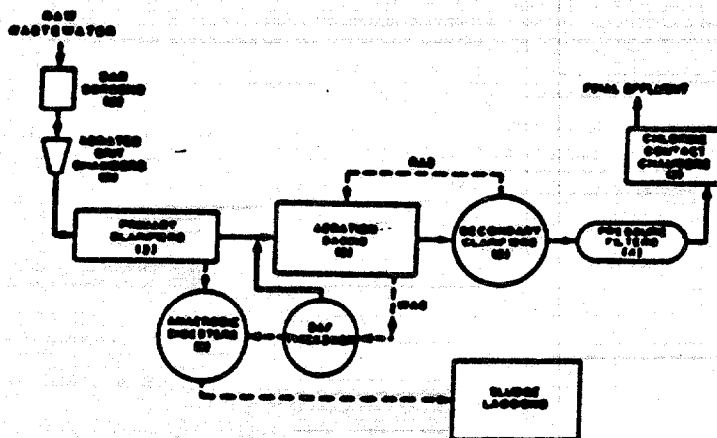
Typical (Upset)

3-4 (6-7)

20 (30)

1-3 (1-3)

1 (2-3)



**DUCK CREEK SEWAGE TREATMENT PLANT, PAW PAW SEWAGE
TREATMENT PLANT
Denison, Texas**

The Duck Creek Sewage Treatment Plant (DCSTP) is one of four small treatment facilities owned, operated and maintained by the City of Denison, Texas. The plant is located on the far north end of town, adjacent to the Red River. The Paw Paw Sewage Treatment Plant (PPSTP), located on the east end of Denison, is one of the older sewage treatment facilities operated by the City.

The DCSTP and PPSTP had consistently failed to meet NPDES discharge standards for BOD and suspended solids prior to 1978. A state court order required Denison to monitor the industrial waste discharges from the four largest industries in town on a 5 day per week basis. Two of these industries were deleted from the court order when they initiated their own pretreatment program and constructed pretreatment facilities. In 1985, Denison was issued an EPA Administrative Order to implement a pretreatment program. A revised City Sewer Ordinance was approved by the City Council on January 6, 1986.

The four largest industries in Denison are all food processors; of these, the two that do not pretreat are the major source of industrial interferences at the PPSTP. These two industries are a food oil refinery, and an oily-type food processor (margarine, salad oil, etc.). These two facilities have a common discharge pump station and have the capability to flow by gravity to the DCSTP.

The influent to the DCSTP has a BOD₅ concentration of 400-500 mg/l and a TSS concentration ranging from 50-300 mg/l. Concentrations of fats, oils and grease (FOG) cause problems at the DCSTP, particularly when one of those industries releases a batch dump of their waste. Apparently, such an incident had occurred on Monday, February 3, 1986, and the residual effects of this batch dump were noted at the plant during the JMM site visit on Tuesday, February 4, 1986. Major effects included clogging of the bar screen, and scum on the secondary clarifier. There would also have been a thick grease layer on the oxidation ditch, but a previous day's rain (4 inches in 6 hours) had caused the headworks to overflow, and a substantial quantity of grease was noted on the ground adjacent to the oxidation ditch. Due to the overloaded condition and lack of parallel units at this plant, there are no process control alternatives for responding to these batch discharges other than bypassing the bar screen and running the influent comminutor. The DCSTP is in compliance with the NPDES discharge permit about 65 percent of the time. When it is in an upset condition, effluent BOD and TSS concentrations exceed 140 mg/l and 200 mg/l, respectively, on the average.

The most significant industrial flows are processed through the PPSTP. This plant receives upwards of 400,000 gpd of industrial waste with a BOD ranging from 1,200 to 2,000 mg/l, TSS range of 400 to 650 mg/l and FOG of 300 to 400 mg/l. The FOG is noted to be extremely high. In addition, the flow contributed by these industries is only a City estimate, based on their flow measurements when the flow from these industries has been diverted to the DCSTP due to pump station problems. The two industries in question claim total combined discharge of 140,000 gpd, based on pump station wet well size and

pump cycling. There is no flow meter on this pump station, nor have water consumption records been used to gage discharge flow due to uncertainties regarding in-plant consumptive use values.

At the time of the administrative order, the City was asked to guarantee NPDES discharge permit compliance for the PPSTP. To accomplish this, a chemical addition system was added to feed cationic polymer and liquid alum into the PPSTP influent flow. The result of this program is the reduction of effluent BOD and TSS from averages around 35 mg/l each, to less than 20 mg/l each. The cost of this chemical addition program is approximately \$8,000 per month, essentially due to the cost of alum (\$137/ton, 8 gpd feed rate) and polymer (\$1.85/lb, 6.1 gpd feed rate). Due to mechanical problems at this plant, one of two trickling filters is out of service, and has been so for over two months, awaiting arrival of replacement parts from the manufacturer.

Other problems noted at PPSTP are the grease accumulation, and foam due to detergents. The grease can accumulate on the bar screen, primary clarifier, or chlorine contact tanks, and can plug the trickling filter distributor ports. Several ports were noted to be plugged during the site visit, and the wastewater superintendent noted that if the ports are cleaned, they generally plug up again within less than one hour's time. The greatest accumulation of grease was noted on the chlorine contact tanks' water surface. The City has received permission from the EPA to periodically pump these tanks down to remove accumulated grease. Foaming was noted at the downstream side of the mechanical grit chamber, and the influent splitter box to the chlorine contact tanks. The oil and grease do not appear to significantly impact effluent quality.

In mid-1985, the City hired a consultant to examine their wastewater treatment system and recommend any necessary modifications. The consultant recommended a new 2.5 mgd Trickling Filter/Activated Sludge plant to be constructed by late 1987, replacing both the Paw Paw and Duck Creek Sewage Treatment Plants.

PAW PAW SEWAGE TREATMENT PLANT DENSON, TEXAS

Design Flow
Secondary Treatment 2.5 mgd
Trickling Filter

Location
Population Served North Texas
1,000

INFLUENT WASTEWATER

Ave. Flow, mgd
% Industrial
BOD₅, mg/l
SS, mg/l

Typical (0 year)
1
10
400
400

Industry

Food Processor
Food Oil Processor

SIGNIFICANT INDUSTRIES

Flare
(1000 gpd)

24
100

Potential Pollutants

BOD, TSS, FOG
BOD, TSS, FOG

PLANT LOADING

Primary Clarifier

Overflow Rate, gal/sf/day
Detention Time, hours
Effluent BOD₅, mg/l
Effluent SS, mg/l

Typical (0 year)
230
7
100
80

Trickling Filter

Loading lbs BOD₅/1,000 cu ft
Return Flow, %

Typical (0 year)
5 (15)
400

Secondary Clarifier

Overflow Rate, gal/sf/day
Detention Time, hours

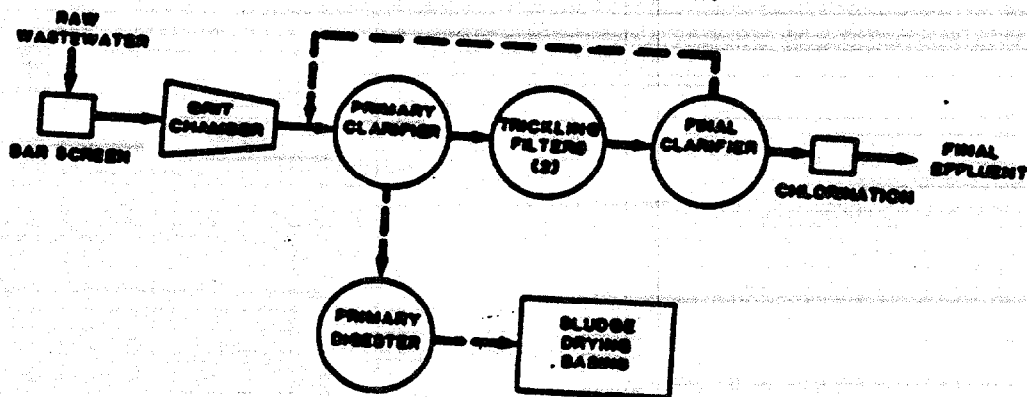
Typical (0 year)
350
4.5

PLANT PERFORMANCE

BOD₅, mg/l
SS, mg/l

Permit Limit
20
20

Typical (0 year)
10 (34)
12 (34)



DOCK CREEK SEWAGE TREATMENT PLANT DENVER, TEXAS

Design Flow:
Secondary Treatment:

1.0 mgd
Activated Sludge (Oxidation
Ditch Syst. Aerobic)

Location:
Population Served: North Texas
7,500

INFLUENT WASTEWATER

Ave. Flow, mgd
% Industrial
BOD₅, mg/l
SS, mg/l

Typical (Upset)
1.2
52
120
370

Industry
Food Processor
Food Processor
Wood Processor

SIGNIFICANT SUBSTRATES

Fluoride
(1000 ppm)
39
4 up to 30
30

Problem Pollutants
BOD, O & C
BOD, TSS, O & C
Grease

Primary Clarifiers

No Primary Clarifiers

PLANT LOADING

Aeration Basin

F/M, lbs BOD₅/lbs MLSS/day
MCR, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

Typical (Upset)

0.13
7.7
1,000
26
50
1.5 - 2.0

Secondary Clarifiers

Overflow Rate, gal/sq/ft/day
Detention Time, hours

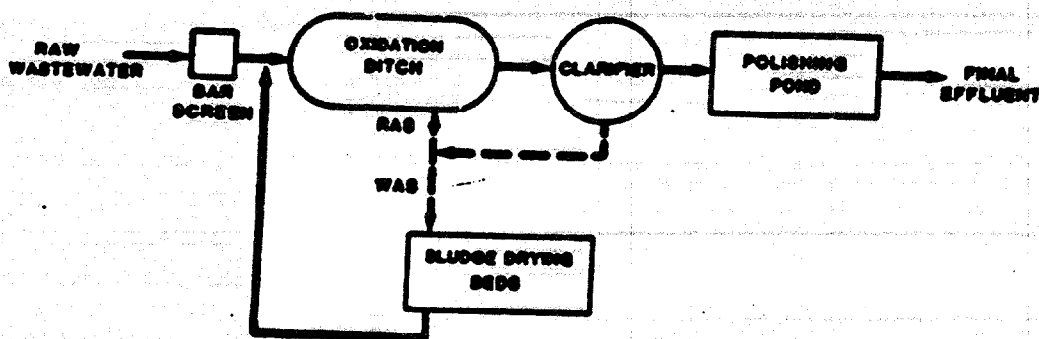
Typical (Upset)
0.6
2.9

PLANT PERFORMANCE

BOD₅, mg/l
SS, mg/l

Permit Limit
20
20

Typical (Upset)
35 (140)
45 (200)



PARIS WASTEWATER TREATMENT PLANT

Paris, Texas

The Paris Wastewater Treatment Plant (PWTP) was constructed in 1972 to serve the municipal and industrial needs of this north Texas community. The City fathers had adopted a policy of bringing industries into the City by making generous allowances in the areas of municipal taxes and utilities. There were no industrial waste discharge requirements for industries in Paris until 1983, when the EPA issued an administrative order for the City to improve discharges from the PWTP such that they would comply with their NPDES permit. The City Utilities Department staff then set up a comprehensive 90 day industrial discharge monitoring program to determine which industrial discharges were responsible for the treatment plant overloading. The plant was designed to treat a maximum BOD loading of 8,000 lbs/day, but was receiving an average of 10,000 lbs/day with peaks of over 15,000 lbs/day. The sampling program revealed that greater than 53 percent of the influent BOD loading was attributable to four large industries.

The Utilities Department developed an industrial sewer use ordinance which was put into effect by the City Council in late 1983. This ordinance is strictly enforced by the Utilities Department. In the first year, over \$350,000 in surcharge fees were collected. This has subsequently dropped to about \$190,000 per year. The Utilities Department required the four largest industries to install permanent recording flow meters and refrigerated composite samplers. A second set of industries was required to install flow meters, flow monitors, and manholes for the City to take samples. A third group of industries was required to install a Parshall Flume, with the City making periodic flow measurements and taking samples. Finally, the smallest industrial dischargers were required to install an effluent manhole from which the City could withdraw samples. The result of the ordinance and strict enforcement of the surcharge program is that the majority of the large industries have all installed their own pretreatment systems. Two have their own NPDES permits, and one of these operates a 6 mgd overland flow treatment system.

Of the major industries in Paris, most are food processors or paper products manufacturers. One of the four largest, however, is a categorical (metal finishing) industry. This discharger still contributes an average of 40-50 mg/l of ammonia, 30 mg/l of copper and 17 mg/l of zinc into the PWTP. The City has worked with this industry to develop a timetable whereby it will reduce its ammonia discharge to 30 mg/l and its heavy metals discharge to EPA categorical standards by June 1986. The presence of heavy metals in the sludge limits sludge disposal to non-agricultural lands.

The PWTP now receives an average of 6,000 lbs/day of BOD₅, which it can easily handle with its existing facilities. Occasional slug loads of up to 27,000 lbs/day have been received at the PWTP. These are typically handled by increasing the MCRT and MLSS concentrations. The most recent episode of a slug of high strength waste did not have any adverse effects on the PWTP.

The City is starting construction of an upgrade to the PWTP which is scheduled to be completed by December, 1986. The major feature of the upgrading will be the addition of an 80 foot diameter by 15 foot deep plastic media roughing filter ahead of the activated sludge system. This is being paid for by the largest industry in town, and will increase the design BOD₅ loading for the PWTP to 15,000 lbs/day.

One other major feature of the City's ordinance is their refusal to take wastes which are high in oil and grease content. The PWTP has no primary clarifiers and can therefore not easily remove oily wastes from the flow stream. All local restaurants are required to have a grease trap to remove grease from their waste flows before discharge to the City sewer system.

At the core of the City's successful pretreatment program is their willingness to enforce the City ordinance, and their laboratory. The City has its own water/wastewater laboratory which produces duplicate analyses of all samples. The City provides effluent analyses of industrial discharges to industries at no charge to that industry. The City data are consistently accurate, and match quarterly EPA sampling data.

PAGE WASTEWATER TREATMENT PLANT PAGE, TEXAS

Design Flow
Secondary Treatment

**4 mgd
Aerobically Sludge
(Continuous Sludge Extended
Aeration)**

Location

Population Served

North Texas

34,000

INFLUENT WASTEWATER

Typical (0 speed)

Acc. Flow, mgd
4
% Industrial
15
BOD₅, mg/l
200 (1,000)
SL, mg/l
200

Industry

**Food Processor
Metal Finisher**

SIGNIFICANT INDUSTRIES

**Process
(1000 gpd)**

**210
100**

Pollution Potentials

**BOD₅, TSS
NH₃, Cu, Zn**

PLANT LOADING

Primary Clarifiers

No Primary Clarifiers

Aeration Basins

**7/4, lbs BOD₅/lbs MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l**

Typical (0 speed)

**0.09 (0.13)
16 (20)
1,500 (2,500)
22.5
90
0.1**

Secondary Clarifiers

Typical (0 speed)

**Overflow Rate, gal/sq/ft/day
Detention Time, hours
SVI, ml/gm**

**600
2.1
120 (140)**

PLANT PERFORMANCE

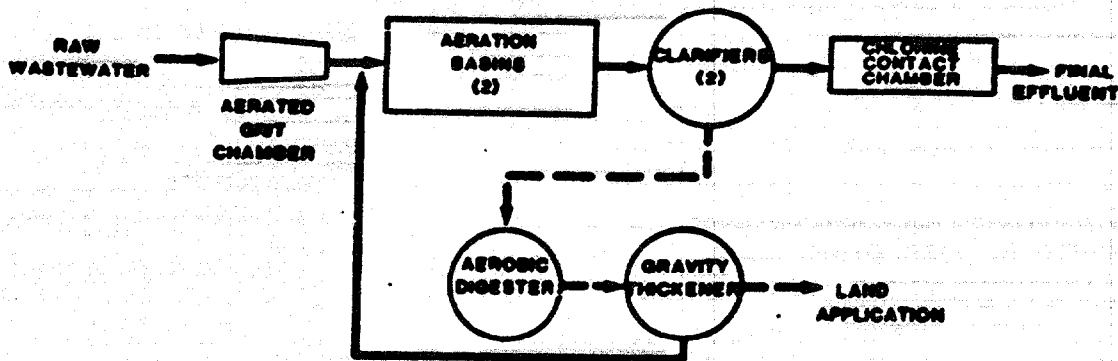
Permit Limit

Typical (0 speed)

**BOD₅, mg/l
SL, mg/l**

**20
20**

**10 (30)
10 (30)**



POST OAK WASTEWATER TREATMENT PLANT

Sherman, Texas

The Post Oak Wastewater Treatment Plant (POWTP) treats all municipal and industrial wastewater generated in the City of Sherman, Texas. In 1982, the City was issued an EPA Administrative Order to institute a pretreatment program. With the assistance of the Director of Utilities for the City of Paris, a sewer use ordinance was developed and passed by the City Council in 1983.

In addition to the implementation of the sewer use ordinance, the POWTP was upgraded in 1983 with the addition of an activated sludge system following the existing trickling filters. As soon as this system was placed on-line, the plant effluent concentrations of BOD and TSS dropped from over 30 for each, to less than 13 for each. Prior to the addition of the activated sludge system, the POWTP was never able to respond to industrial discharges due to a lack of control on the trickling filter recycle pumps. The POWTP now consistently meets its discharge permit requirements.

The implementation of the sewer use ordinance led to the installation of pretreatment plants at all five of the City's major industries. One of these, a coffee processor, utilizes an overland flow system during dry weather, and discharges to the POWTP during wet weather. Wet weather flows to the POTW typically peak in excess of 17 mgd.

Another industry of interest is an edible oil - food processor. This industry has installed a pH adjustment/heat treatment system to remove fats, oils and grease from its discharge, but still discharges in excess of 2,000 mg/l BOD, 600 mg/l TSS and 600 mg/l FOG to the POWTP. This user pays approximately \$ 250,000 per year in surcharge fees. Influent FOG to the POWTP averages 40-50 mg/l due to dilution, and does not cause any significant process problems.

The one major categorical industry is a chromium plater who discharges in excess of 1 mgd to the POWTP. This user has installed a chromium reduction, pH adjustment, metal hydroxide precipitation pretreatment facility to reduce its surcharge liability. Dewatered metal hydroxide sludge is trucked to Houston for appropriate disposal.

POST OAK WASTEWATER TREATMENT PLANT SHERMAN, TEXAS

Design Flow:
Secondary Treatment:

6 mgd
Two-stage Trickling Filter/
Activated Sludge

Location:
Population Served:

**North Texas
30,000**

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	2.5
% Industrial	~3
BOD ₅ , mg/l	275
SS, mg/l	162

Industry
Food Processor
Fruit and Products Mfr.
Alcohol Processor
Electronics Mfr.

**Flowrate
(1000 gpd)**
610
400
250
1,320

Possible Pollutants
BOD, TSS, FOG
BOD, FOG, pH
BOD, TSS, FOG, Color

PLANT LOADING

Primary Clarifiers
Overflow Rate, gal/sd
Detention Time, hours

Typical (Upset)
500
1.0

Trickling Filter
BOD₅ loading, lbs/1,000 cu ft/day
Recycle, %

Typical (Upset)
33
100

Secondary Clarifiers
Overflow Rate, gal/sd
Detention Time, hours

Typical (Upset)
415
4.1

Aeration Basins
F/M, lbs BOD₅/lb MLSS/day
MCRT, days
MLSS, mg/l
Detention Time, hours
Return Flow, %
D.O. Level, mg/l

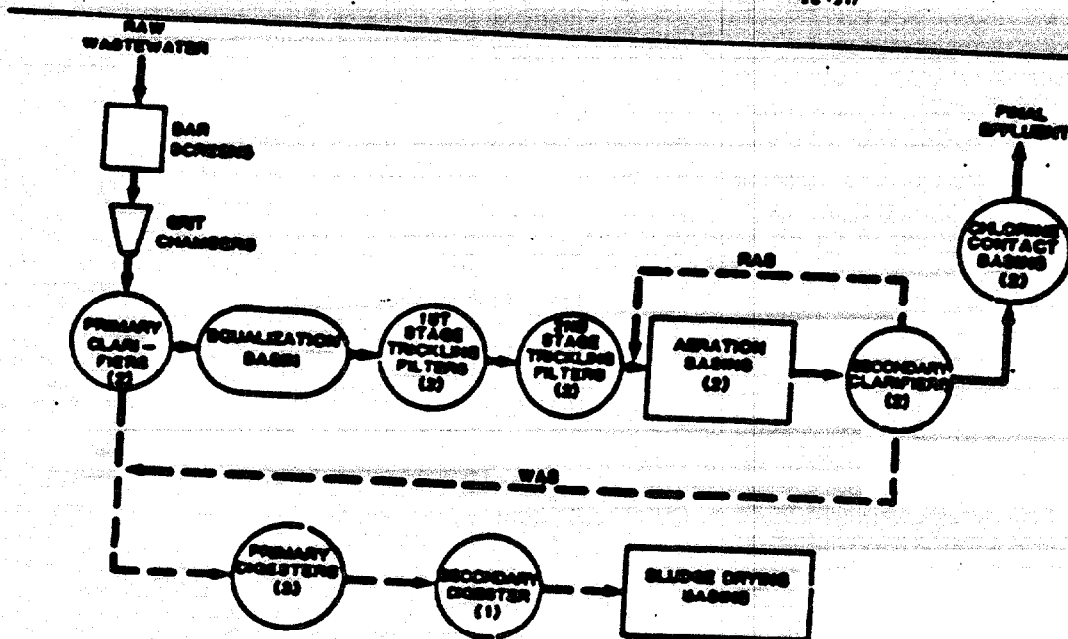
Typical (Upset)
0.27 (0.30)
5-6
1,000 (2,000)
7.5
10 (100)
1

PLANT PERFORMANCE

BOD₅, mg/l
SS, mg/l

Permit Limits
20
20

Typical (Upset)
0.30
12 (37)



NEWBERG WASTEWATER TREATMENT PLANT

Newberg, Oregon

The Newberg Wastewater Treatment Plant (NWTP) has experienced periodic episodes of non-compliance with their NPDES Permit for approximately ten years due to fluctuating BOD loadings, and biological upsets caused by excessive copper discharges. In general, copper discharges have not limited sludge disposal options. With implementation of a pretreatment program and tighter industrial discharger limits, interference incidences have become more infrequent since mid-1984. NPDES discharge permit compliance should increase in the next two years as some industrial waste permit limits are tightened and a completely new treatment facility with greater hydraulic capacity is brought on line.

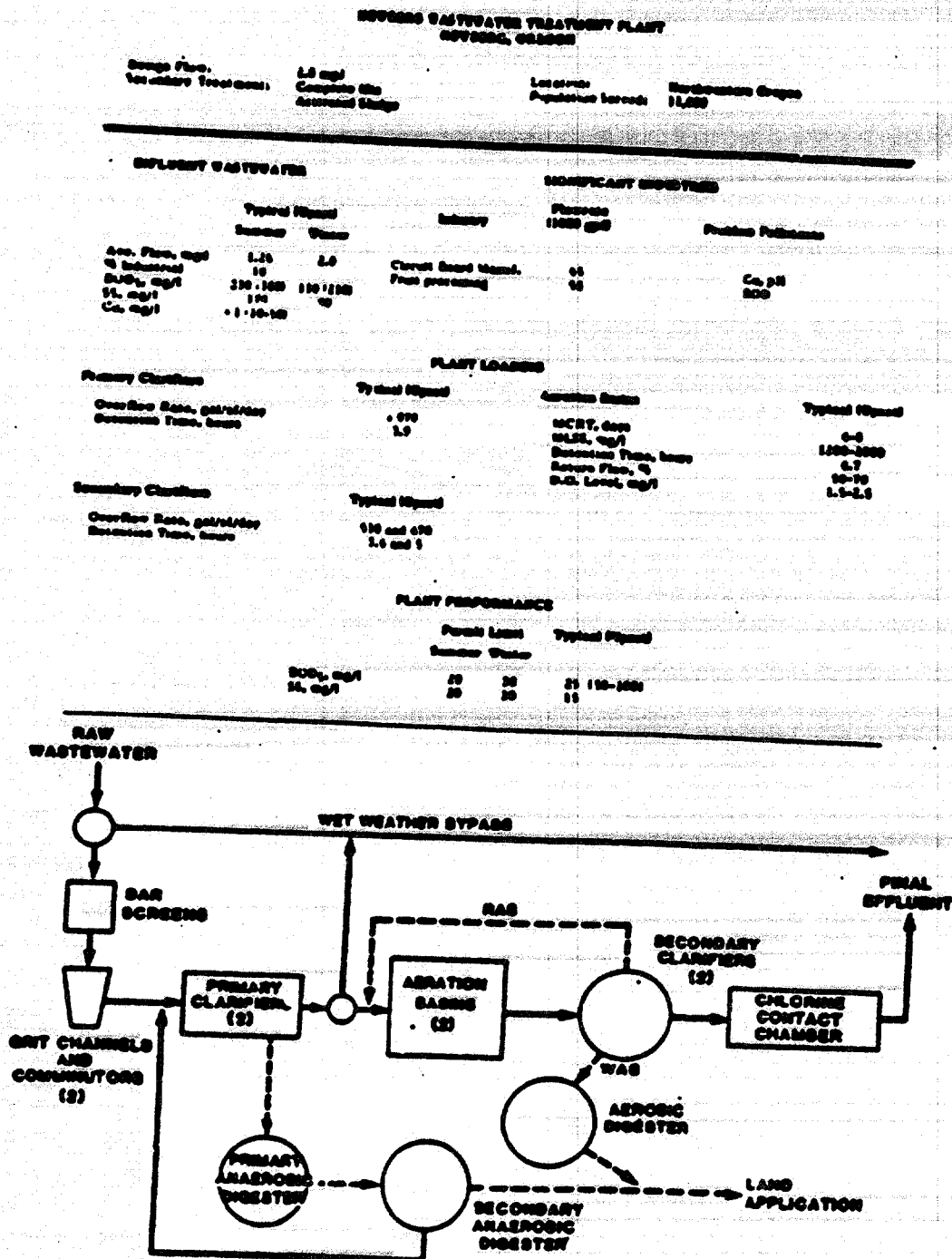
The two main industrial contributors to the NWTP are a circuit board manufacturer (cbm) and a fruit processor (fp), both of which operate year-round. The cbm has been discharging wastewater to the NWTP since 1974, but the flowrate was increased in 1978 when it was discovered by the Oregon Department of Environmental Quality (DEQ) that a wastestream with copper concentrations as high as 50-80 ppm was being directly discharged to a local stream. Subsequent biological failure of the NWTP showed copper levels as high as 100 ppm in the primary clarifier sludge. The incident required reseeded of the biological population and 45 days to completely recover. Because of regular upsets, the City began sampling and testing for pH and copper in 1981 at the first manhole downstream of the cbm facility. The City experienced great difficulty in working with the cbm to reduce copper levels and periodic discharge problems continued until May, 1984 when copper discharges caused a complete activated sludge and anaerobic digester failure. With pressure on the City by the DEQ and an updated sewer ordinance with more "teeth", the City aggressively pursued compliance by the cbm. A "show cause" hearing resulted and rather than address the pretreatment issue, the cbm chose to cease production and lay off 50-60 people.

The cbm reopened later that summer with the new pretreatment equipment required to comply with its industrial waste discharge permit. Since installing pretreatment, the cbm has been in constant compliance. Wastewater monitoring of the cbm continues.

The second major industrial discharger which has caused the NWTP to violate its NPDES Permit is a processor of pie cherries. The fp requires on the average, one third of the NWTP BOD treatment capacity which normally does not present a problem. However, waste strength variability can result in the fp contributing 2700 pounds of BOD in one day to the plant which is designed to handle 3200 pounds/day. With the addition of the domestic BOD load, the biological process is overwhelmed. Typically, this occurs in the summer at low plant flowrates and can cause the effluent BOD to rise to 50 mg/l. The fp has been responsive to the City's pretreatment program and tighter industrial waste discharge limits, which have attempted to solve the problem. Stricter industrial discharge limits may be imposed by the City when the fp's permit is renewed in the near future. A good working relationship between the City and the fp has made corrective actions easier to implement than in the case of the cbm.

In dealing with all industries in town, the City has attempted to work cooperatively to implement pretreatment and issue industrial waste discharge permits. The City has paid up to one half of all consulting fees associated with industries implementing pretreatment, and has paid for most laboratory analysis of wastewater samples.

Newberg experiences substantial I/I which on occasion contributes to non-compliance problems by hydraulically overloading the treatment process. The I/I problem is being addressed by the City.



METRO-WEST POINT TREATMENT PLANT

Seattle, Washington

The Municipality of Metropolitan Seattle (METRO) has had an operational industrial pretreatment program since 1969. With minor modifications, the program was EPA-approved in 1981 as one of the first in the nation. Successful reductions in influent wastewater and primary sludge heavy metal concentrations during the last five years can, to a great extent, be attributed to implementation and enforcement of pretreatment standards. As an outcome of this, self-monitoring by industrial dischargers augmented with year-round spot monitoring by Metro's Industrial Waste Section has reduced the incidences of toxic upsets in the anaerobic digesters of the West Point Treatment Plant and in the activated sludge process of the neighboring Renton Treatment Plant.

The Metro-West Point Treatment Plant provides primary treatment and sludge digestion for an average daily wastewater flow of 132 mgd, 4.7 percent originating from industrial sources. Approximately 70 metal finishing/electroplating industries discharge to the sewer system in addition to a variety of other categorical and non-categorical industries. Records of periodic digester upsets go back as early as 1967, but their occurrences have become less frequent since 1980, coinciding with substantial overall reductions in heavy metal concentrations. Past upsets directly linked to toxic metals (generally chromium) caused increased volatile acid concentrations, increased carbon dioxide content of the gas produced, reduced gas production, and in a few cases caused complete failure of the digesters. An October, 1980 chromium spill to the West Point facility caused a typical upset and resulted in the plant influent chromium concentration jumping 10 fold to greater than 2 mg/l. Primary sludge concentrations of chromium reached 710 mg/l, resulting in a 30 mg/l increase in digester concentrations above their normal 16-17 mg/l level. Land application of the sludge was not altered, as presently there are no established allowable metals application rates for silvicultural use.

Figure C-6 below typifies the reduction in metals realized during the 1981-1985 time period. Plant influent chromium levels dropped approximately 55 percent while the digested sludge concentrations were reduced by more than 40 percent. The magnitude of these decreases are typical of other heavy metals as well, averaging 44 percent for chromium, cadmium, copper, lead, nickel and zinc combined (see the accompanying data sheet). The primary reason for the reduction of cadmium and chromium concentrations is improved industrial pretreatment. In addition to pretreatment, a less corrosive city water supply has also resulted in lower background metal concentrations for the other metals, especially for copper. The city recently began chemically conditioning its water in an attempt to extend conduit life.

Success of the Metro Industrial Pretreatment Program can be attributed to a number of important factors including:

- development of stringent local limits for industrial discharges;

- year-round industrial waste sampling programs supported financially by industry; and
- follow-up procedures to industrial waste spills, taking enforcement action and levying fines when necessary.

Metro has recently implemented the following steps to improve their pretreatment program:

- information exchange with industries through the use of quarterly newsletters and personal communication, and
- increasing public awareness of industrial discharge violators by publishing the names of violating companies in local papers along with a statement of Metro's enforcement policy.

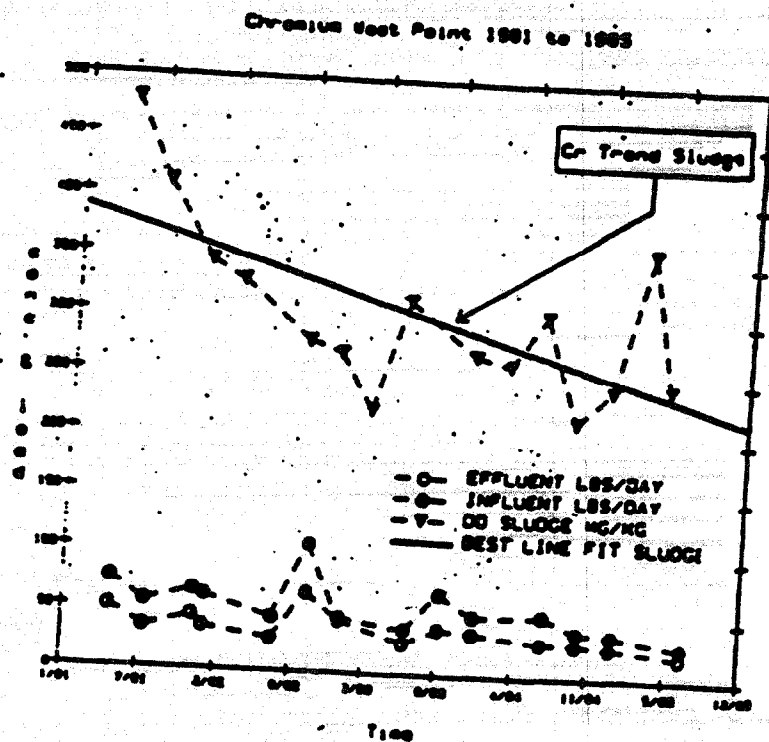


FIGURE C-6
WEST POINT CHROMIUM CONCENTRATIONS

WEST POINT TREATMENT PLANT SEATTLE, WASHINGTON

Design Flow: 125 mgd
Primary Treatment

Location: West-Central Washington
Population Served: 500,000

INFLUENT WASTEWATER

	Typical (Upset)
Ave. Flow, mgd	133
% Industrial	5
BOD ₅ , mg/l	160
SS, mg/l	260
Cr, mg/l	0.05 - 2.0

Industry: Metal finishing and electroplating

Flowrate (mgd): 1.1

Problem Pollutants: Cd, Cr, Cu, Ni, Zn

PLANT LOADING

Primary Clarifiers

Overflow Rate, gal/sd/ft ²
Detention Time, hours
Effluent BOD ₅ , mg/l
Effluent SS, mg/l

Typical (Upset)

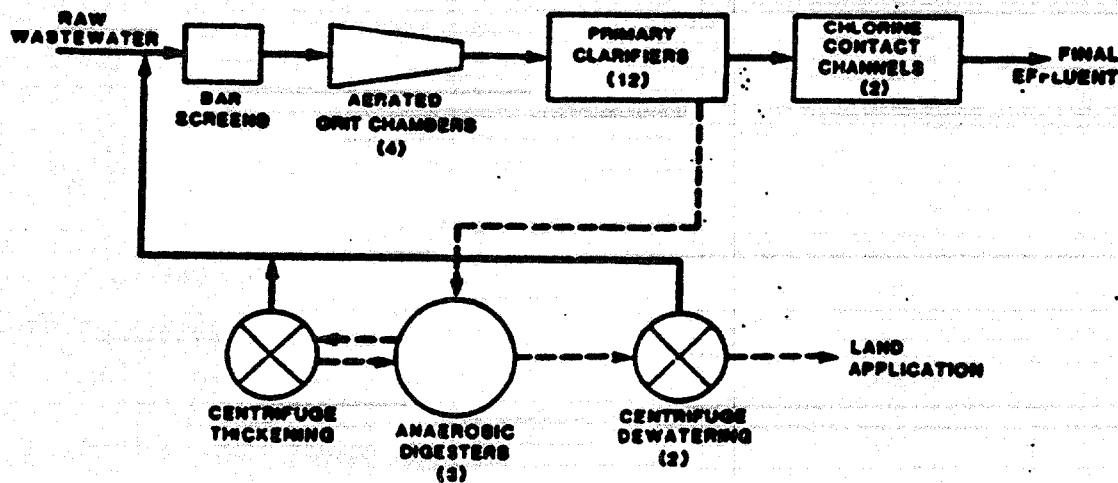
1000
1.50
75-110
60-90

Digested Sludge Metal Concentrations

	1981 Level	1986 Level
Cadmium, mg/kg	65	25
Chromium, mg/kg	400	250
Copper, mg/kg	1300	700
Nickel, mg/kg	160	120
Lead, mg/kg	600	400

PLANT PERFORMANCE

	Permit Limit		Typical	
	Summer	Winter	Summer	Winter
BOD ₅ , mg/l	135	85	110	75
SS, mg/l	125	65	90	60
Cr, mg/L	0.07	0.07	<0.05	(0.15)



**HOUSEHOLD ODORS ASSOCIATED WITH THE
USE OF CHLORINE DIOXIDE DURING
DRINKING WATER TREATMENT**

**Robert C. Hoehn, Professor
Andrea M. Dietrich, Assistant Professor
William S. Farmer, Graduate Student
Margaret P. Orr, Graduate Student
Department of Civil Engineering
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061**

**Ramon G. Lee, Director
Research and Technology
American Water Works Service Company, Inc.
Voorhees, New Jersey**

**E.M. Aieta, Vice Pres. & Mgr.
Applied Research Department
James M. Montgomery Consulting Engineers, Inc.
Pasadena, California**

**D.W. Wood, Graduate Student
Gilbert Gordon, Volwiler Research Professor
Department of Chemistry
Miami University
Oxford, Ohio**

**Presented at Annual AWWA Conference and Exposition
Sunday Seminar Entitled:
"Identification and Treatment of Taste and Odor Compounds"
Los Angeles, California**

June 18, 1989

000638

HOUSEHOLD ODORS ASSOCIATED WITH THE USE OF CHLORINE DIOXIDE DURING DRINKING WATER TREATMENT

Robert C. Hoehn, Professor
Andrea M. Dietrich, Assistant Professor
William S. Farmer, Graduate Student
Margaret P. Orr, Graduate Student
Department of Civil Engineering
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061

Ramon G. Lee, Director
Research and Technology
American Water Works Service Company, Inc.
Voorhees, New Jersey

E.M. Aieta, Vice Pres. & Mgr.
Applied Research Department
James M. Montgomery Consulting Engineers, Inc.
Pasadena, California

D.W. Wood, Graduate Student
Gilbert Gordon, Volwiler Research Professor
Department of Chemistry
Miami University
Oxford, Ohio

INTRODUCTION

Overview

In the past decade, many water treatment specialists in the United States found it impossible to meet the maximum contaminant level (MCL) for trihalomethanes (THMs) at their water treatment plants (WTP) as long as they applied chlorine to raw water. Their choices were few: either eliminate preoxidation and predisinfection altogether or substitute for chlorine some oxidant that would not form THMs. Many opting for the latter discovered that chlorine dioxide (ClO_2) was an excellent alternative, because most of the benefits derived from preoxidation with chlorine could be attained by preoxidation with ClO_2 , yet THM-formation could be reduced. One aspect of ClO_2 use was of concern, however, namely that the oxidant and its by-products, chlorite (ClO_2^-) and chlorate (ClO_3^-), are potential problem species from a public health point-of-view (Condie 1986, Couri *et al.* 1982). Thus, the practical dosage of ClO_2 that can be applied is limited to about 1.0 mg/L in most instances. Even at low dosages, however, ClO_2 has been shown to be beneficial when it is applied as a preoxidant (Hoehn *et al.*, 1987, Hoehn *et al.* 1988). Chlorine dioxide not only fails to form THM when it reacts with organic matter, it also can destroy or otherwise alter THM precursors so that the THM-formation potential of the water is reduced (Lykins and Griese 1986, Wederhoff and Singer, 1987).

While even low concentrations of ClO_2 (0.5-1.5 mg/L) can be beneficial, many utilities have encountered unusual taste- and-odor complaints when they apply the oxidant. The complaints, which range from "chlorinous" and "rosene-like" to "like cat urine", typically begin within one or two days after the initiation of the ClO_2 feed and cease just as quickly when it is eliminated. The odors cannot be detected at the treatment plant and appear randomly in the distribution system, often affecting only one or two homes in a given area. A common response by the utilities, after being frustrated in their attempts to find the cause of the problem and being intimidated by extremely vocal customers,

is to cease using ClO_2 altogether. Others have found that they can minimize the complaints by reducing the dosage to low levels, often less than 0.5 mg/L.

The American Water Works Association Research Foundation (AWWARF) became interested in this problem and issued a request for proposals. In July, 1988, AWWARF awarded a grant to Virginia Tech to work cooperatively with the American Water Works Service Company (AWWASCo) in solving the problem. The project, entitled "Cause and Control of Taste-and-Odor Problems Associated With the Use of Chlorine Dioxide as a Primary Disinfectant and Preoxidant," is the basis for this paper.

Objectives of This Project

The objectives of this project, which was funded by the AWWA Research Foundation, were as follows:

- to collect and analyze historical data from utilities where ClO_2 has been and is being used and document (1) whether taste-and-odor problems have occurred, (2) the nature and extent of the problems if they have occurred, (3) the descriptions of the odors, (4) the locations and patterns of complaint occurrences in the distribution system, (5) the nature and concentrations of oxidant residuals measured both at the treatment plant and at customers' homes where complaints were registered, (6) the nature of piping to the homes where problems have been reported, and (7) water-quality characteristics from plant records;
- to identify and characterize the specific agent(s) responsible for the taste-and-odor episodes associated with chlorine dioxide treatment of raw water by flavor profile analysis (FPA) and by laboratory and field studies of both water and air from a treatment plant and in the distribution system where the problems have occurred and are likely to occur again;
- to reproduce in the laboratory the odors observed in the field in order to establish the conditions under which they are produced; and
- to propose methods for controlling the taste-and-odor problems associated with preoxidation of raw water with chlorine dioxide.

Objectives of This Paper

The objectives of this paper are as follows:

- to describe the steps taken during the AWWARF-funded project to identify the cause(s) of the taste-and-odor problems associated with WTP-applications of chlorine dioxide;
- to discuss the results of the field and laboratory studies conducted in two cities that routinely use chlorine dioxide as a preoxidant;
- to present evidence linking the odors to new carpeting in households where complaints have originated; and
- to describe laboratory research in progress to identify the odorous compounds and to evaluate treatment processes that might be used to prevent their formation.

As will be explained, the data collected to date suggest that many of the offensive odors are not caused by odoriferous compounds in water that has been treated with chlorine dioxide but rather are the result of reactions *in air* between chlorine dioxide, which escapes from the drinking water when the tap is opened, and organic compounds already present in the air of certain homes.

PAST STUDIES OF ODORS RELATED TO CHLORINE DIOXIDE

Projects in Virginia

Odor complaints were numerous during research projects involving full-scale applications of ClO_2 at two WTPs in Virginia (Hoehn *et al.* 1987, Carlson and Hoehn, 1986). At both locations, ClO_2 was applied as a preoxidant at dosages ranging from 0.5 to 1.5 mg/L. Customers' descriptions of the odors (none complained of tastes) could be classified broadly in two categories: chlorinous and organic. Specific descriptors included:

- strong chlorine
- oily
- petroleum
- kerosene
- insecticide
- cat urine

One WTP was able to eliminate the odor problems by reducing the dose to approximately 0.4 mg/L; the other elected to discontinue the treatment when faced with ever-increasing numbers of complaints. Organics analysis by gas chromatography/mass spectroscopy (GC/MS) failed to identify the odorous compounds.

Projects Conducted by AWWASCo

At WTPs owned by the American Water Works Service Company, the odor problem had been minimized by reducing ClO_2 dosages to low levels, the exact dosage being site specific. One intensive investigation was conducted at Lexington, Kentucky, in 1986 (Trussel and Aieta, 1986). Odor descriptors used by customers at affected locations included:

- bug spray
- cat urine
- cat litter
- old leather shoes
- organic chemical
- kerosene
- between kerosene and chlorine

Water samples collected throughout the treatment plant and distribution system were evaluated by flavor profile analysis (FPA) and analyzed by GC/MS, and even though numerous compounds were detected, the offending odors could not be attributed to any of them.

Typical Characteristics of the Odor Complaints

The following summarize the facts about the nature of the odor complaints received prior to the initiation of the AWWARF project:

- Odors were never detected at the treatment plant itself
- Only a few customers complained at random locations in the distribution system.
- Neighboring homes typically were free of the odors.
- Complaints ceased within one or two days when treatment with chlorine dioxide was discontinued.
- Odors were undetectable in samples returned to the laboratory.
- The most commonly used descriptors of the odors were "kerosene-like" (or some similar term) when an organic smell was detected and "chlorinous" or "strong chlorine" when hydrocarbon-like odors were absent. An occasional "cat-urine-like" odor was reported also.

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- Most customers complained of smells in the morning only, while a few detected them at all hours of the day and night.
The odors were most typically noted in cold water in bathrooms and utility rooms.

Characteristics Common Among Utilities

Characteristics that were common among the facilities where chlorine-dioxide-related odors had been observed included:

- Surface water, either a river or a reservoir, was the source of raw water in every instance.
- Chlorine dioxide was added only as a pretreatment, typically at dosages ranging from 0.5 to 1.5 mg/L.
- Chlorine was never added until after settling. It typically was added on top of the filters and again as the water either entered or left the clearwell.
- None of the WTPs ammoniated the water to form chloramines for distribution-system protection.

INITIAL HYPOTHESES REGARDING THE NATURE AND CAUSES OF THE ODORS

At the inception of this project, hypotheses regarding the nature and causes of the odors associated with the use of chlorine dioxide were formulated on the basis of the available evidence. These included the following:

1. The odor-causing substances are formed at random locations in the distribution system and not at the treatment plant itself.
2. Some feature of individual homes, such as the piping, is involved in the generation of the compounds responsible for the odors.
- The odor-causing substances are recoverable from the water by closed-loop stripping and are identifiable by gas chromatography/mass spectroscopy.

These hypotheses dictated the structure of the sampling and analysis program, which is described in the following section.

METHODS AND MATERIALS

Many of the details regarding sampling and analysis associated with this project have been purposefully omitted because the final AWWARF project report, which is due for completion in June, 1990, will contain a thorough description. Sufficient information is given here, however, to adequately describe these aspects of the project.

Description of Sampling Sites

Two AWWASCo-owned WTPs -- Kentucky-American's Kentucky River WTP in Lexington, KY and West Virginia-American's Kanawha Valley WTP in Charleston, WV -- were selected for field sampling. The raw water source was a river at each location, and each system had experienced problems with the typical kerosene/cat-urine-like odors during times of chlorine dioxide application. The Lexington facility generally received more complaints than did the one in Charleston.

Lexington, Kentucky

The Kentucky River WTP, which receives raw water from the Kentucky River, is a 40 MGD facility that adds chlorine to the raw water at dosages of approximately 1.0 mg/L. The plant was visited October 11, 1988; chlorine dioxide treatment had begun October 10. The WTP consists of Aldrich purification units, which are complete within themselves in that mixing, flocculation, settling, and filtration (trimedia) are all provided in each unit. Polymer is added for coagulation, and flocculation and clarification occur in the upflow, sludge-blanket Aldrich units. Potassium permanganate

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and chlorine dioxide are added as preoxidants, while chlorine is added at the clearwell. Ammoniation facilities have recently been added but were not operational at the time of this study.

Sites sampled for organics and oxidant residuals analyses on October 11, 1988, at the plant included the following:

- raw water from the Kentucky River
- treated water after the addition of chlorine dioxide
- filtered water
- clearwell (after chlorination)

Three customers' homes were sampled during the Lexington visit. One of these was a single-family residence, the home of a customer (Customer A) who had complained of "cat-urine odors" during each of the past four years during periods when chlorine dioxide was being added at the WTP. A neighbor's home (Customer C) was also sampled at the same time. Another residence (Customer B), a second-story apartment where odors associated with chlorine dioxide applications were detected, also was sampled. The customer had complained of "coal oil" odors.

Samples of both hot and cold water were collected from the homes of Customers A and C. In addition, a sample was collected at the meter of Customer A. Since Customer B lived in an apartment complex, sampling at the meter was not practical. Only a cold-water sample was collected from inside Customer C's home (the control home), but one from the meter was collected.

Charleston, West Virginia

The Charleston facility is also a 40 MGD WTP. It is divided into two, identical treatment trains, each provided with its own rapid mixer. Alum and polymer are added for coagulation, and each treatment train is equipped with two, circular clarifiers. During critical periods, chlorine dioxide is added to raw water on one side of the plant, typically at 2.0 mg/L, while chlorine is added to raw water on the other side. After filtration through dual media, water from each side of the plant is blended in a common clearwell. Additional chlorine is added to the blended water to provide a free residual in the distribution system.

Sampling sites for analyses of organics and oxidant residuals at the plant on November 5, 1988, included:

- raw water
- settled water after chlorination (east basin)
- settled water after ClO_2 addition (west basin)
- chlorinated water below filter
- chlorine-dioxide-treated water below filter
- mixed effluent from both treatment trains

Only one home where the odor problem was occurring could be identified on the day of the sampling team's visit. This home was a single-family residence, and the customer (Customer D) had complained of kerosene-like odors. A next-door neighbor was not experiencing the odor at the time of our visit (but had in weeks past), so that site was selected for the control. Both hot and cold water samples were collected from the residences of Customers D and E, and samples were collected also at both meters.

Air samples were taken for organics analyses at Customer D's home while both hot and cold water were running in the bathtub to volatilize any dissolved organic compounds that might be present. Air was sampled also from the bathroom of Customer E, but only while the cold water in the bathtub was running. Sampled air volumes were either 10-L or 25-L.

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Sampling and Analytical Procedures

Samples were analyzed for volatile organic compounds by closed looped stripping analysis (CLSA) and GC/MS. All samples taken at the two WTPs and from the distribution system at both Lexington and Charleston were analyzed at Virginia Tech. In addition, a battery of blank or control samples were included for quality control and quality assurance. Selected duplicate water samples were sent on ice by overnight express-mail to Philadelphia Suburban Water Company (Bryn Mawr, PA) for confirmatory analyses.

Analyses of Organic Compounds in Water Samples

At both Lexington and Charleston, water samples obtained from the plant and distribution system were purged of volatile organic compounds by CLSA. Samples were collected headspace-free in acid-washed, 2.3-liter, glass bottles equipped with scintered-glass stoppers and stripped immediately to maintain sample integrity. Samples were collected at the treatment plant one-hour apart to allow enough time between sampling for processing to be completed before the next one was collected. Distribution samples were stored on wet ice until analysis by CLSA in the WTP laboratory. A maximum of six hours, and typically one to three hours, elapsed before any given sample was processed.

Prior to stripping, each sample was placed in a constant-temperature water bath to equilibrate at 30° C for 30 minutes. After equilibration, 300 mL of the sample was decanted to provide the headspace that was to be recirculated during CLSA. Each sample was spiked with 1 mL of a chloroalkane internal standard consisting of chlorohexane, chlorodecane, and chlorooctadecane for quantification purposes. After displacing the ambient air in the CLSA system and the 300 mL headspace with grade 4.5 helium, organic compounds were purged from the water sample and adsorbed on activated carbon filters (1.5-5.0 mg each) using the closed loop stripping process developed by Grob. A Brechbuhler AG (Schlieren, Switzerland) CLSA unit was used to circulate the gaseous headspace through a sparging device in the 2-L water sample, through the carbon filter, and back to the sparger. In this manner, relatively volatile compounds were removed from the water and adsorbed on the carbon.

During CLSA, a heated water bath maintained the temperature at 30° C and a heated metal block held the carbon filter at 40° C to prevent condensation. After the stripping was completed, the carbon filters were placed in clean, glass vials, purged with helium, and either refrigerated or kept on ice until they could be extracted with solvent.

Adsorbed organic chemicals were extracted from the activated carbon with carbon disulfide. Typically, between 15 and 20 μ L of solvent was passed repeatedly through the filter before being collected in an acid-washed, glass sample holder. Organic compounds were analyzed by direct injection of 1 μ L of extract onto a 30 m DB-1701 capillary column (J&W Scientific, CA) in an HP 5890A GC.

The following were the GC conditions:

Initial Temperature	40° C
Initial Time	8.0 min
Program Rate	8.0° C/min
Final Temperature	250° C
Final Time	0.0 min
Carrier Gas (He) Flow Rate	30 mL/min
FID Split Flow	3:1
ECD Split Flow	20:1
ECD Make-up Gas	N ₂

GC was equipped with both flame ionization and electron-capture detectors (FID and ECD, respectively). The GC/MS system was an HP5880 GC interfaced with a VG 707H MS unit equipped with an 11-250 datasystem. Electron ionization and library matching with additional manual mass spectral interpretation was used to identify specific compounds.

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The following were the MS conditions:

Ionization Energy	70 eV
Acceleration Voltage	4 kV
Scan Rate	1 sec/decade
Mass Range	40-375 amu
Source Temperature	200° C

Sampling and Analysis of Organic Compounds in Air Samples

A known volume of air (10 or 25 L) was pulled by vacuum through sample tubes packed with about 4 g Tenax adsorbent that was previously cleaned with solvents. The air sampler, a Delsaga Gasprobenehmer Model GS 212 instrument (Heidelberg), was equipped with a flow meter for accurate metering of the air, and a timer to permit sampling of any desired volume. During sampling, the flow rate of air through the Tenax column was 1 L/min.

Ten liters of air were sampled from the filter galleries of both parallel treatment trains at the Charleston WTP. In the field, one 25-L sample was collected from the bathroom of Customer D's home (where the odors were detected) as the hot water was running full-force into the bathtub. An additional 10-L sample was collected at this same location while the cold water was running.

Each Tenax column was enclosed in its own air-tight shipping container and shipped by air express, along with an unused column (a "travel blank") to Montgomery Laboratories in Pasadena, CA for analysis. Volatile organic analyses of the samples were conducted by GC/MS. The sample trap was connected to a Tekmar 5010 desorber than could be programmed to heat the trap, causing the adsorbed, organic compounds to be desorbed and enter the GC column. The C, A Hewlett Packard Model 5980 GC, was coupled to a Hewlett Packard Model 5870 Mass Selective Detector. The column was 30 m X 0.25 mm ID (DB-5).

Oxidant Analyses

Samples collected at Lexington and Charleston from the treatment plants and at customers' homes, as previously described, were analyzed for chlorine, ClO_2 , ClO_2^- , and ClO_3^- . Analytical methods were the amperometric method of Aieta *et al.* (1984) and the flow injection analysis of Gordon and his associates from Miami University (Gordon *et al.* 1989, Themelis *et al.* 1989). The accuracy of the amperometric method for ClO_2 analysis is poor at low concentrations (i.e. < 0.5 - 1.0 mg/L), but the flow injection analysis is quite accurate at that level. Measurements of chlorine and ClO_2^- by amperometric titration are reasonably accurate at even low concentrations (< 0.2 mg/L), but ClO_3^- analyses, according to Aieta *et al.* (1984), are inaccurate at concentrations less than 0.25 mg/L. In general, the flow injection analysis gives superior results. The estimated uncertainties associated with the analyses of ClO_2 , ClO_2^- , and ClO_3^- at concentrations of 0.02 mg/L by flow injection analysis at the time of sampling in Charleston were, respectively, ± 0.10 mg/L, ± 0.03 mg/L, and ± 0.05 mg/L. At 0.40 mg/L concentration, the uncertainties were ± 0.10 mg/L, ± 0.02 mg/L, and ± 0.04 mg/L, respectively.

Amperometric titration was accomplished by the method of Aieta *et al.* (1984) with a Fischer-Porter instrument, while the flow injection analyses were with a Tecator Model 5020 Analyzer with a Tecator Chemifold II Manifold. The detector was a Tecator 5024 FIAsstar Photometer that consisted of a 5032 Detector Controller and a 5024-011 Photometer optical unit. A printer is included with the detection system and allows modification of the analytical readout from the detector controller by means of a direct digital communication monitored at 370 nm with a 1-cm path length flow cell (18 μL volume). The flow rate of each stream was 0.9 mL/min and allowed 75 injections per hour. The flow system was constructed from 0.5 mm i.d. Teflon tubing. Five replicate injections per sample were made in all cases (Themelis *et al.* 1989).

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Flavor Profile Analyses

FPA team from Montgomery Laboratories collected samples from the water treatment plant along the treatment train and the distribution system at both homes in the Charleston distribution system where other samples had been collected. The procedure for FPA will not be described here, except to say that it involves both tasting and smelling most of the water samples. Raw water is not tasted because of potential health hazards.

Samples were collected from the homes of Customers D and E and placed on ice. Immediately upon return to the WTP, the samples were evaluated by FPA, then packed in wet ice for shipment to California for subsequent evaluations four days later. Both hot and cold water samples were collected in the homes.

While water was running from the taps in the homes, the FPA team (and other members of the research team) cupped their hands under the flowing water, allowing it to splash onto the palms, and placed their nose immediately above the water surface, inhaling deeply as they did so and noting the type odor that was detected. Before the sample bottles were filled for return to the laboratory, the flow from the tap was reduced to minimize volatilization of organic compounds that might be associated with the odors.

RESULTS AND DISCUSSION

Odor Evaluations By Research Team Members

In the course of sampling from the homes in both Lexington and Charleston, the research team varied in their descriptions of the odors. Some members of the team described the odors immediately as "kerosene-like", while others described them as "like cat urine". Notably, several members of the team developed severe headaches during extending sampling in the homes where the odors were occurring, both in Lexington and Charleston.

In both cities, the odors were detectable throughout the day. Customer B was visited in the evening, and the odors were still quite strong. These findings differ from earlier observations that customers detected the odors primarily in the early morning when showering.

Organic Compounds in Water Samples

The organic analyses performed by Virginia Tech and Philadelphia Suburban Water Company showed the presence of several types of compounds, including trihalomethanes (THMs), benzene, C_1 -substituted benzenes, alkanes, and alkenes. These compounds were present at concentrations of either parts per billion (ppb) or parts per trillion (ppt). Several compounds appeared in control samples analyzed by both laboratories, which, of course, eliminated any consideration of them as true analytes from samples collected in the field.

If the compounds not identified in the blanks, there appeared to be no compounds or classes of compounds that could be associated with the kerosene and cat-urine odors in homes. Many of the compounds identified in homes in which the odors were detected were present also in neighboring homes that had no odor problems and in samples from the water treatment plants. These included chlorinated, brominated and iodinated THMs; C_1 -benzenes, benzonitrile, dibromochloroethene, phthalic anhydride, 2-methylpropanenitrile, N-ethenamine, ammonium benzoate, and exachlorethane. All compounds were present in the high ppt to ppb range.

Organic Compounds in Air Samples

A variety of compounds was collected from air at the Charleston WTP and from the homes. Compounds found at both the WTP and in the homes included THMs, aliphatic hydrocarbons ($< C_{10}$), benzene, alkyl-substituted benzenes (C_1 -), acetone, and chlorinated C_2 compounds. Alkenes (C_4 to C_6) and benzaldehyde were detected in the WTP air but

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not in household air, while ethanol, methylisobutylketone, and 1,1,2,2-tetramethylcyclopropane were recovered from the home with the odor problem but not from the filter gallery or nonodorous home.

Several aliphatic hydrocarbons were reportedly recovered from the air of the home that was experiencing the odor problem but not at any of the other sampling locations, but the interpretation of these data is clouded somewhat by the fact that several closely related hydrocarbon isomers were recovered from the other sites also. Hydrocarbons appear to be ubiquitous in air regardless of where it is sampled. Likely sources of these compounds include combustion products of petroleum products, a variety of household products, paints, and other products. If hydrocarbons had been recovered only from the home experiencing the odor, one might conclude that the cause of the kerosene-like odors had been discovered; however, kerosene is a mixture of aliphatic hydrocarbons containing from ten to sixteen carbons, alkyl derivatives of benzene, and naphthalene. The hydrocarbons detected in the home of the customer who reported the complaint contained too few carbon atoms to be associated with the traditional petroleum product known as kerosene.

None of the compounds found exclusively in the home experiencing the odor problem could be identified as the cause of the cat-urine-like odor, which also was detected by several members of the sampling team. The compounds responsible for that particular essence possibly cannot be readily trapped on Tenax or, perhaps, they are not detected during the GC analysis because of some condition that either causes their catalysis or is incompatible with their recovery.

Flavor Profile Analyses

Both the kerosene-like and cat-urine-like odors were detected in the homes of Customers A and B in Lexington and Customer D in Charleston. Only the Montgomery Laboratories personnel actually participated in the organoleptic evaluations of Charleston samples by FPA. The petroleum odor noted at Customer D's home was not perceptible during the actual FPA analysis conducted several hours later at the WTP. Each panelist did detect a strong chlorinous odor, however.

Samples collected the next day from Customer D's home and evaluated by FPA were said by one panelist to have a kerosene-like odor at threshold level, but the second, more experienced panelist did not detect that odor. The chlorinous and chlorine dioxide odors persisted for four days, but the kerosene-like odor was not evident after that time. Significantly, neither of the typical odors described by complainants were ever detected in samples collected from the treatment train at the Charleston WTP, nor could they be detected in water collected from the customers' meters. The odors were only detectable inside the complainants' homes, both in Charleston and in Lexington.

Oxidants In Water Samples

One of the more important aspects of this study, or so it has proven to be, was the accurate determination of low levels of oxidant residuals, particularly ClO_2 , in the distribution system. Flow injection analysis, as has been mentioned previously, can detect chlorine dioxide at extremely low concentrations with much less error than the amperometric titration method. Concentrations ranging from 0.03 to 0.12 mg/L ClO_2 were detected in the two Charleston homes.

Water collected below the filters at the Charleston WTP contained low levels of ClO_2 , though water in the clearwell, which also contained nearly 2 mg/L chlorine, contained 0.12 mg/L ClO_2 . While much more investigation is needed to ascertain the exact mechanism for the regeneration of ClO_2 beyond the treatment plant, the oxidant definitely was present at the customers' taps.

Investigations into the mechanism(s) and rate(s) of ClO_2 regeneration are continuing. Two possibilities are being considered, both involving reactions between residual ClO_2^- and hypochlorous acid. The following equations illustrate these hypothesized reactions.

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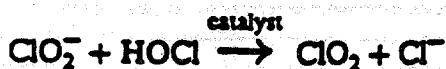
[1]



[2]



[3]



[4]

The first hypothesis is depicted in equations 1-3, which show a regeneration of both ClO_2 and ClO_2^- . The "water demand" could be caused by any number of reducing substances in the distribution system, both inorganic and organic. Equation 4 illustrates the second hypothesis, which is a more direct production of ClO_2 by reaction between HOCl and ClO_2^- . This reaction could be catalyzed by one of several catalysts, including iron. Other by-products would include Cl^- and ClO_2^- .

Since the threshold level of ClO_2 in air is approximately 0.1 mg/L, the likely explanation for numerous complaints of "strong chlorinous" odors at times when of ClO_2 use at the WTP is that the oxidant itself is escaping from the customers' water when the tap is opened. The odor of ClO_2 is much more pungent than of chlorine, which causes some customers to describe their water as smelling "like a swimming pool," which resembles the odors of dichloramines and trichloramines.

FIELD-STUDY SUMMARY AND CONCLUSIONS

The field study was designed on the premise that the compounds responsible for the offensive odors that develop in the distribution system when ClO_2 was being added as a preoxidant at the WTP was in the water. Reasons for the randomness of the complaints, being limited usually to one customer in any given neighborhood, were not understood, and the study was designed to investigate possible causes of that phenomenon as well.

The sampling program was designed to determine if the odorous compounds were being generated during the treatment process and could be detected at the water treatment plant. Possibilities that the odors were not being generated until the distributed water entered the customer's piping were also considered. Both air and water were sampled and analyzed by the best techniques available. Two laboratories were involved in the analyses of volatile organic compounds in water; a third laboratory analyzed the air samples.

Once the data were collected and analyzed, the following conclusions seemed to be the only possible ones:

1. Organic compounds responsible for kerosene-like and cat-urine-like odors in the distribution system during times of ClO_2 applications at the WTP are not in water either leaving the plant, entering the customers' service connections from the distribution system, or in the customers' residential piping.
2. Strong chlorinous odors, reported by some complainants during times of ClO_2 applications at the WTP, are caused by ClO_2 , which is formed in the distribution system by mechanisms unknown, that is volatilized when the customer's tap is opened.

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LINK BETWEEN NEW CARPETING AND OFFENSIVE ODORS

The discovery of ClO_2 residuals in the customers' homes was a turning point in the search for the cause of the kerosene-like and cat-urine-like odors because until then, statements, which the authors had heard, attributing the odors to the presence of new carpeting in the homes of complainants were dismissed as unlikely explanations. The suspected link was cited in a draft report of another AWWA Research Foundation report (George 1989). George, in discussing problem areas associated with WTP conversions to chlorine dioxide treatment, stated:

There have been several complaints of extremely disagreeable odors originating from the potable water. In all of these cases so far, the complaints have have originated from homes or businesses in which new carpet has been installed. It is difficult to understand any cause/effect from this reported new-carpet association, but the utility believes there is some relationship.

Reference was being made to the Mobile (Alabama) WTP, which began adding ClO_2 in 1983 to help control THM formation.

Additional Evidence Supporting Link Between Odors and New Carpeting

Soon after the research team completed their field studies, the principal investigator was contacted by Mr. Gary Mostert, Superintendent of the Latham (New York) Water District, which supplies water for the Town of Colonie. He reported finding new carpeting in the homes of 30 complainants since October 1, 1988. The principal investigator was contacted by the New York State Health Department for collaboration since numerous complaints had been received and customers were concerned about the potential health effects of the compounds causing the offensive odors.

The local newspapers had been quite active in reporting the problem, and the explanation that new carpeting was somehow involved seemed to satisfy most of the customers. Two customers reportedly installed point-of-entry devices containing granular activated carbon and successfully eliminated the odor problems. Personnel from the WTP who investigated the complaints stated that water samples taken outside the home immediately upon collection did not smell, even though the odors were sometimes overwhelming inside the residence.

In the period between October 1, 1988, and April 30, 1989, the water utility in Colonie has received 54 complaints from individuals who had installed new carpeting. The vast majority described the odors either as kerosene-like or like cat urine, approximately equal numbers using each term, but other descriptors included "gas-like", "gassy", "chemical", "strong chemical", "strong chlorine", "permanent wave solution", and a variety of other terms, including "septic", "skunk", "pine sap", "rotten eggs", "sulfide", "strong body odor", and "ichthymol". The latter is a petroleum-based salve used in treating boils and other similar dermal conditions.

Numerous other utilities that use chlorine dioxide some or all of the time have since been in contact with the principal investigators in this project and have provided additional evidence linking new carpeting and the offensive odors. These include the following:

- Duck River Utility Commission (Tullahoma, TN)
 - 19 complainants, all with new carpeting
 - Terms used to describe odors included cat urine, kerosene-like, and merthiolate.
- Dean's Mill WTP (Mystic, CT)
 - Small system (3500 customers): 3 complainants, all with new carpeting
 - Descriptors included kerosene-like and plastic.
- Southern Nevada Water System
 - 5 of 10 complainants had new carpeting.

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- Descriptors all related to kerosene-like
- In previous years, no complaints had been received. Applications typically began in October and ending by the end of December. The utility delayed adding ClO_2 until January, 1989, last year, and complaints began almost immediately.
- The suggested reason for complaints only in 1989 was that colder weather forced occupants to shut doors and windows, presumably allowing chemicals emanating from new carpeting to accumulate in the home.
- Hamilton, Ohio WTP
 - ClO_2 applied to groundwater entering distribution system
 - Generator also produces some chlorine.
 - Number of complaint unknown, but kerosene-related terms are common.
 - Used ClO_2 for several years without odor complaints.
- Kansas City, Kansas
 - Kerosene-like odor and "strong body odor" descriptors are common.
 - Has experienced the problem for two years and had noted that all complaining customers had new carpeting.
- West Virginia-American WTP (Charleston, WV)
 - New carpeting had been installed in the home of customer D, where the kerosene-like odor was detected during this project, several days prior to the project team's visit.

Still other utilities are being identified almost daily at this writing through responses to a questionnaire that has been sent to more than 40 utilities that apply ClO_2 .

To date, no utility that pretreats with ClO_2 , then ammoniates after chlorination and before the water enters the distribution system has reported the typical odors associated with ClO_2 use at other utilities. Recently, the Lexington, KY facility converted to chloramines, and shortly thereafter fed ClO_2 for slightly longer than one week at relatively high doses without experiencing any complaints from once-vocal customers.

Not all complainants have had new carpeting. Five of 10 in the Southern Nevada Water System did not, but only two of these described the odors with terms that might be construed to mean kerosene-like. One used the term "oil", the other, "gas". At Lexington, Customer A's complaints predated the time when new carpeting was installed, but complaints were continuous since the carpeting was installed. Customer C in Lexington lived in a second-story apartment and did not have new carpeting. Some information presently being received suggests that new carpeting is not always in the homes of complainants. Other airborne organics likely will produce the same reactions.

Direct Link Between Odors and New Carpeting

The research team recently conducted an experiment at a local church where new carpeting had been installed. The experiment consisted on atomizing solutions of ClO_2 of varying strengths in a room that had been recently carpeted. No water supply was in the room. Concentrations of the ClO_2 solutions ranged from 0.1 mg/L to 7 mg/L. The kerosene-like odors were very apparent to both investigators who performed these experiments; one of the team noted the kerosene-like odor at first, then reported that it changed to "cat-urine-like" as more and more of the ClO_2 solution was atomized in the room. Five members of the church staff, none of whom were familiar with this project and previous descriptors used by customers to describe the odors, were invited to participate in the study. Two of the five described the odors as with terms relating the odors to kerosene or petroleum products, while three used the "cat urine" descriptor. One person said "strong body odor", a term also used by customers in Kansas City.

This information seems to confirm that there is a definite link between new carpeting and chlorine dioxide. The present hypothesis is that organic compounds used in the preparation of carpeting volatilize in the home providing precursor organic compounds to react with ClO_2 in the drinking water that escapes when the customer opens a faucet. Numerous sources of the precursor organic compounds may exist, of course, and studies are in progress to identify other potential sources.

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Research Currently In Progress

Laboratory studies are being conducted to identify the specific organic compounds given off by new carpet that react with ClO_2 . Identification of the actual odorous products is the major goal of these studies. Air in the newly carpeted church room has been concentrated on CLSA carbon traps and analyzed. Additionally, strips of new carpeting have been placed in glass chambers to permeate the atmosphere with the potential precursors of the odorous compounds, then analyzed before and after the addition of chlorine dioxide. To date, benzene, styrene, 3-methylcyclopentanone, and 3-nitro-1,2-benzenedicarboxylic acid have been recovered from air containing organic compounds released from carpet "reacted" with chlorine dioxide, but no major breakthroughs have occurred.

Research also is underway to develop ways to reduce chlorite concentrations at the water treatment plant before distribution. Sulfur dioxide and powdered activated carbon are being investigated. If an economic method for removing ClO_2 can be found, WTPs can apply higher dosages of ClO_2 and minimize the residual oxidant concentrations entering the system. Thus, not only would the odor problems be curtailed or eliminated, the potential health effects of higher oxidant by-product concentrations would not be of concern.

CONCLUSIONS

Based on data presently available, the following conclusions are warranted:

1. Chlorine dioxide can be regenerated in the distribution system either directly or indirectly by reactions between chlorine and chlorite.
2. The kerosene- and cat-urine-like odors can be produced by reactions between ClO_2 escaping from water and organic compounds in household air.
3. New carpeting is a common source of the organic compounds that are precursors to the offensive odors noted in distribution systems of water treatment plants where chlorine dioxide is being applied. Other sources of the precursor organics are likely.
4. The odor problems can be prevented if either free residual chlorine or ClO_2 are removed from the distributed water. Ammoniation to form chloramines should eliminate the odor problems.

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Seafood is Leading Cause of Foodborne Illness Outbreaks

WASHINGTON - Contaminated seafood is the leading known cause of foodborne illness outbreaks, according to a new report published by the Center for Science in the Public Interest (CSPI). The next biggest causes are eggs, fruits and vegetables, beef and poultry. Those findings are in CSPI's *Outbreak Alert!* report, which was released this week at the annual meeting of the American Public Health Association.

Based on approximately 1,600 food-poisoning outbreaks affecting more than 70,000 individuals between 1990 and 2001, CSPI found:

- Seafood caused 340 outbreaks with 5,133 cases of foodborne illness.
- Eggs and egg dishes caused 271 outbreaks with 10,827 cases.
- Fruits and vegetables caused 148 outbreaks with 9,413 cases of food poisoning.
- Beef, the meat product most likely to be linked to an outbreak, caused 134 outbreaks with 6,089 cases of foodborne illness.
- Contaminated poultry caused 79 outbreaks with 4,279 cases.

"Seafood and other foods regulated by the Food and Drug Administration (FDA) caused four times more outbreaks than meat and poultry products, which are regulated by the U.S. Department of Agriculture (USDA)," said Caroline Smith DeWaal, CSPI's director of food safety. "Despite that, the FDA has only one-tenth as many food-safety inspectors, and about one-third of the inspection budget of the USDA. That represents a huge gap in consumers' protection against unsafe food."

FDA currently has only 150 inspectors to check on 3.7 million shipments of imported food and inspects domestic food plants only once every five years. FDA recently informed Congress that it needs significant new resources to protect the food supply, including \$800 million to enhance domestic inspections and \$540 million to inspect 20 percent of the shipments of imported food. Because of the threat of bioterrorism, the Bush Administration last week requested emergency funding from Congress, including \$61 million to increase imported food inspections and to modernize the import data system.

“The Bush Administration has acknowledged serious gaps in FDA’s food-safety program that need to be repaired.” said DeWaal. “In addition to increasing FDA’s funding, the Bush Administration and Congress should combine federal food safety programs into a single food safety agency with modern tools to address new hazards, like bioterrorism and mad cow disease.”

Outbreak Alert!*, published annually by CSPI since 1999, provides the most comprehensive listing of foodborne illness outbreaks linked to the food source and the regulating agency. The report is compiled from authoritative sources, including the Centers for Disease Control and Prevention (CDC), state and local health departments, and medical and scientific journals. Outbreaks of unknown origin, i.e. where no food or pathogen could be identified, are not included in *Outbreak Alert!

[CSPI U.S.] [News Releases]